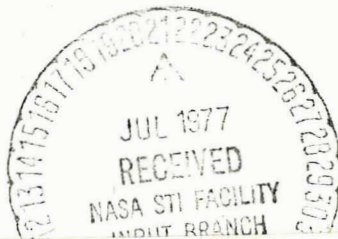


DE-SMS-II-050

LIFE SCIENCES SPACELAB MISSION SIMULATION II

**SMS II CREW
DEBRIEFING
TRANSCRIPTS**



(NASA-TM-74791) SPACELAB MISSION SIMULATION
2, CREW DEBRIEFING TRANSCRIPTS: DEBRIEFINGS
CONDUCTED FEBRUARY 3 AND 4, 1976 (NASA)
260 p

N77-81082

00/14 Unclas
38389

National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

APRIL 1976

38389

DE-SMS-II-50

SPACELAB MISSION SIMULATION II

CREW DEBRIEFING

TRANSCRIPTS

DEBRIEFINGS CONDUCTED
FEBRUARY 3 AND 4, 1976

SMS II CREW DEBRIEFINGS

Spacelab Mission Simulation II was conducted at the Johnson Space Center from January 26 through February 1, 1976. The following NASA personnel participated as crewmembers:

F. Story Musgrave, M.D. - Mission Specialist (MS)
C. F. Sawin, Ph. D. - Payload Specialist 1 (PS1)
R. S. Clark, Ph. D. - Payload Specialist 2 (PS2)

This document contains the transcripts of the crew debriefings, which were held as follows:

February 3, 1976 (a.m.) - Management Debriefing
February 3, 1976 (p.m.) - Systems Debriefing
February 4, 1976 (a.m. and p.m.) - Science Experiments
Debriefing
February 4, 1976 (p.m.) - Core Equipment Debriefing

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MANAGEMENT DEBRIEFING

Integration

HUFFSTETLER

-- want the crew to outline what occurred during the test, their observations there during the test - primarily to allow all of us here to ask questions. Questions that - any questions, that is, especially those that pertain to the test conduct, the philosophies of the test, questions that may pertain to what . . . by the debriefing. Those are important, especially at this time. We've got a lot of briefings to make in the next couple of months that are going to be the basis for the plans, especially in the life sciences and now in the S&ID areas. So Story and Bob and Chuck did a super job in the test. And I understand that - Marv Bradley tells me that we had 261 experiment runs during the test, and I don't know what the planned is, but we figure that it must be at least 40 percent over what was planned. These are complete runs, these aren't nickel-and-dime things, but complete runs. There are 6 alternate experiments, and I know up to day 4 they had run something like 26 of the alternate experiments, which we'd put in there just in case there was enough time. So they must have had 50 runs or so on alternates. And like Story just said, you could go over there and switch things on and you want more data on those same experiments and they'll all work.

MUSGRAVE

As Bill said, we don't have a formal debriefing outline, and we're just kind of a takeoff point for anyone else to raise any questions. This is the management debriefing, which will be, - We won't get into all of it, the nuts and bolts and things, you know, into the very basic things. We'll just try to present in fairly brief fashion - It'll be a takeoff point for an over-view of the simulation. I think one place to start is how they differ from the last And again this is my point of view and it may not be, of course, always correct. The complexity of hardware was something I thought was very significantly different. We had a much, much more complex payload this time, and the integration tasks - this made the integration task a lot more difficult. Instead of having the trailer we had last time, we did, of course, have Orbiter middeck

and flight deck, and the tunnel. In terms of being able to evaluate - And as we'll see, I think we did a good job, as good as you could, making some contributions toward Orbiter habitability. So that was a big difference. We had a two shift operation and that contributed an awful lot in terms of the problems you get into doing that, and we had a multidisciplinary mission. Having the cosmic-ray lab, which contributed, I think, an awful lot, to what we're going to learn about operating the Shuttle Spacelab program in the future.

That's something you also need to look - When you look at multidisciplinary things, life sciences is not strictly life sciences. And looking at the kinds of payloads we've had on these sims, even within the life sciences discipline - If you look at the instrumentation that's required to get the job done, it in essence is a multidisciplinary mission. In other words, there's nothing peculiar about mass spectrometers in life sciences. You need them in physical sciences, likewise for gas chromatography, pressure transducers, all those other things, FR 1300, data management, and these sorts of things. Those are things which are applicable not just to life sciences, but to all forms of payloads. So even within the life sciences experiments, there are aspects, which are required by many different disciplines. But in terms of - It was important to look at the integration of a physical scientist within the life sciences experiments, which is not something that's in the Baseline Op's plan if you look at this. If you read the BOP's it says, you know, the physical scientist will do the physical sciences, and the life sciences will do the life sciences and that sort of thing. But when you get into integration of a crew or a team, it gets down to, everyone's going to do those things, which they need to do, to get the job done. I think those are some of the big differences between this one and the last one; the complexity of the payload, having an Orbiter middeck and flight deck, a two-shift operation, and a multidiscipline approach. I think those were the big things. I'll lead the discussion off in terms of - I've got sort of an outline of how we might approach this thing. Starting with the integration process because chronologically that's something that has to come earlier, look at the training of the ops team, both the flightcrew and the ground crew, look at flight control, flight activities. Take a look at our contributions to payload

design, Spacelab design, Orbiter design, find a couple of comments maybe on core equipment.

In terms of integration, we did have a much more complex piece of machinery. You can't put it down in terms of numbers, but if you look at what we flew in Skylab, and many of you can comment on this - if you look at the total medical package on Skylab and the total medical package, even not including the cosmic ray, I'd say - you can't put it in terms of numbers, but I'd say we had a more complex and more capable package by two or three times on this mission than we had on Skylab. In other words, it's a real hunk of hardware, and so it was a tremendous integration task. And there are a few pieces of equipment on this, which have been contracted out, designed by NASA for - specifically for space flight. But just looking around the panels, I'd say 90 percent of it is off-the-shelf equipment, which just came out of medical laboratories.

And as Bill said, I think it's extremely important to point out that right today we could run over there today and get good, excellent, valid data on every single experiment that's in that thing. In other words, we had SIMSUP, but we had some other little funnies - but in terms of any kind of - even approaching catastrophic failure of any experiment, there weren't any failures that approached that. There weren't any failures, which could even degrade the data. So right today, we could run over there - 20 experiments, life sciences, and the one of cosmic ray, we could run over there today and crank things up and get excellent data. And so that speaks for itself in terms of the integration process, in terms of the training process, in terms of the total thing, what's it take to pull off a mission. That's there, so by definition the integration process was very successful. Of course, we run these things to try to learn things; and the more complex package that you try to integrate, the more you bite off, the more you're going to learn. So we won't - until this afternoon, won't get into all of the little fine lessons we learned. The more you bite off, the more you're going to learn. In terms of the integration, I think we were really running on a exponential on this one. In other words, things were coming together. It was frightening to me to see the way - and not only me, there were lots of people, but I was - you know, I'm success oriented. You all know me, I'm looking ahead, and looking downstream seeing how we're going to

get the job done. And I think we time compressed a lot of this thing at the end. It may be the way we really end up flying though, if you look at the traffic model for the Shuttle and other things; it may be that some things are going to have to get put off. And I may seem like I'm digressing a little bit, but looking at it the way we did this one, I can really envision flying a life sciences mission like this. Where you have a lot of off-the-shelf hardware that's coming out of people's labs, and you're integrating them and flying them. I can see where we're going to be training on actual flight hardware. We won't be going out and buying duplicates of things that are already in existence. We will be training on flight hardware in the person's lab, PI's lab. We'll be integrating that, and the crew will be participating in the integration process at the integration facility. The same way here, we started training out there in the integration room where these things were going in racks. As soon as there were enough in the racks that we could train with them, we started right there. People were still connecting things and this and that, but the training was valid. Then once the racks got moved into the Spacelab module, we continued the training there. I can envision really doing this sort of thing in the life sciences mission. So it's possible that this compression of time we had at the end here, where everything was coming together all at once, this may be the real world. So it's just possible, although I'd like to see it stretched out a little. You know, we pulled it off and everything's working. Everything went well so you can't knock it. But on the other hand, everything had to work. And, you know, we cranked up the data system on Monday for the first time, we went to work. We were going to fly the next week in integrated sims, and sure enough it worked. If it hadn't, you know things would have been a - more hustle. Okay.

Has anybody - in terms of this integration task has someone got any comments or questions? This is really - we're not the integraters here, we're the crew. But I can keep going and make a few more points on this thing.

MORRISON

Story, do you attribute the lack of malfs to the quality of the hardware or to the smoothness and the better operation of the integration task checkout?

MUSGRAVE

Yes, it's got to be both; they both got to work. But if you look at the interfaces - you can look at the hardware and obviously, if the hardware dies, it dies. But if you

look at the integration task, the complexity of this hardware, and the central data stream, and the support that this kind of hardware required, obviously the integration task had to be extremely well done.

HUFFSTETLER

I think that there are probably two answers to that question. One is normally the hardware - in test 1 we saw it. There are two different phases where you have problems in hardware; one is the early phase, where you haven't really rung it out good and so you're getting a lot of bug-type clingers. The latter phase is when it's getting so old, it's beginning to wear out. We're sort of in the middle phase, we've got a heck of a lot of time on the hardware as a result of test 1 and, subsequent to that, PIs had built up a lot of time on the hardware. And it's not at that last phase yet, where . . . wear out [Microphone being moved] we're working, in some cases, with older hardware, even though it's less sophisticated. I wonder about the comparison to - Something on the integration, one of the things that we found during the integration was that - and it's something we need to carry over into the Spacelab concept I think, is the need for flexibility in location of equipment. Now, we worked up ICD's, which are fine, and those isolate the fluid electrical connection points. And we built up an overall stage layout that showed now . . . should go. But once we started into the actual equipment integration, we found that due to interplay between experiments and some needs operationally for locations of experiments, we needed flexibility to allow us to change - to move experiments within the racks, as late as that level 3 integration process. I think that's something we're going to - that's going to be different from the way it was in Skylab especially. But we should have that flexibility. If it truly is a disciplined laboratory, we should have that flexibility and be allowed that flexibility. And if we do, it's going to work out very well because we are going to be able to move equipment from one rack to another. And from one location to another without the big hassle as far as other interfaces - outside interfaces. We're interfacing with ourselves for a change which is unusual, and it should work very well, I think.

SAWIN

In response to Dennis' question, I think the reliability shown in the test is attributable to the interest shown by the PI's and PE's in helping us shake out the gear. We showed problems to them and they got right on it and like Story said it was a logarithmic approach to the launch of

that thing. A week prior to launch, there was no way that we could have done what we had to do for several reasons: individual experiments with hardware problems; the data system didn't exist; you know, we had no integrated testing; many things. But everyone was working real hard to make this thing go, and attention to detail in almost all cases by the responsible PI and PE's is what made it go. The integration is a separate problem. It went very smoothly, but it has nothing to do with reliability of the experiments except in terms of facility power and such things as that. The integration went much more smoothly than I thought it would go, but again, it did that because instead of just handing the gear over to a group of integration engineers - we didn't have that much manpower as Bill knows, we just didn't have the people. This time it took the PI and PE coming over and following through that integration to make sure that it went well.

CLARK

The cosmic-ray experiment and integrating that into the test - it was a case of coming in with a package that was ready, and our people essentially installing it. But there was a lot of work that went into it and there was a lot of support that was provided by DE personnel and the Northrop personnel over there that really assisted us and made our job easier; made our job very easy to integrate our payload in this test. And we really do appreciate the cooperation and the assistance that we did get in it. We think, from my point of view, that we learned a lot as far as operation is concerned, a lot about Shuttle operations that we need to know in the future.

MUSGRAVE

I think we can exercise the integration process a lot more in the future by getting experiments from further outside, like from Ames or other centers or from the universities and other people who have been principal investigators in the past and that sort of thing. That's what the future is going to be, you can envision, you know, experiments coming from all over the place. And the PI's and PE's, and the engineers we've got on these experiments we integrated this time, they're all very smart, very sharp people, and they've had experience with space flight. Even then it took a lot of doing to get up to fly this thing. It wasn't like it was automatically right there because these people were NASA people for the most part; we did have some outside experiments. I think that would exercise the integration process and the coordination process a lot more, the more we get experiments from the outside. Now I

know we've got a problem doing that right now because - Dr. Dietlein could address that better than I can, but they don't want us to get into soliciting experiments for flight this early on. They want us to stay in house, in terms of these simulations right now. But if you look at the Baseline Ops plan, you - there's an awful lot of responsibility for getting payloads up to flight condition. It's the responsibility of the payload organization not for NASA, but I just don't think it's going to happen that way. We've got so much experience in space flight, I think we need a mechanism for being able to pass on the smarts in this integration process, what it takes to move a laboratory experiment from the laboratory to being flightready. I think we need the mechanism and to be available for helping out the outside PI's and payloads organizations any time they need that kind of help. We need some very smart, with good detail, user's guides. Not just like ICD, these are the requirements your experiment's got to meet, but a sort of an operational user's guide that tells the PI's blow by blow what's going to be involved in flight, we need that kind of thing.

CLARK

I'd like to comment on that one a minute. As far as the documentation that's out on payload accommodation, there's payload accommodation documents out for Spacelab, for Orbiter systems. There needs to be a comparable document, as you say, for the operations. The amount of detail and the information that we needed to provide the various members of the test operations team for our experiment to get it into this simulation - nowhere is there a document that tells what is needed and who needs what information. There needs to be a type of document for the operational accommodations as well as the physical payload accommodations.

MUSGRAVE

Another thing that comes into mind is common-type hardware. We are going, and I guess we need to have this capability of taking anybody's experiment and putting it in, but if you envision like - and Bob you can say something about it, the new CAMAC type of hardware, where for each kind of function you have, you know, from starting with the transducer and all the way to the taperecorder or what else you have, you have common modules, common functional modules, preamps, amps, and all the rest of that stuff. Now if you had experiments that utilized this kind of concept, the flexibility it would give you would be almost infinite. And the capability to change out one for the other or to cannibalize one experiment just temporarily to get another one working or to reduce a total number you

need so that you can use the same system for a whole bunch of different experiments, I think this is something to pursue.

CLARK

On this simulation, there were four PDP-8/E's on the test. The ones for the cosmic-ray payloads was running 24 hours a day doing one function, but the other three were each dedicated to a different task and were all used at separate times. With common interface systems, you have a lot of cost savings, a lot of operational savings, and a lot of savings on integrating the experiments together. And these standards do exist, and we would like to make people more aware of what these standard interfaces are and how they would operate. The PI's could take a look at it in evaluating equipment for future use. This particular concept is a lot further along in Europe than it is here right now. CAMAC has implemented very heavily in Europe, but it has not really started to grow over here very much yet; it's just getting started. It's being used in a lot of industrial processing plants and in the national laboratories, Argon National Lab, Oak Ridge, et cetera. But I think there's a tremendous cost savings and operational savings that would be available for Shuttle if something like this was implemented.

MUSGRAVE

I'm still under the big heading of integration, and some of these things won't seem to fit here so well, but I'd end up with 100 headings if I addressed it any other way. In terms of life sciences dedicated missions, my own feeling is that this thing still supports the idea that, even though we sure learn an awful lot more having a mixed discipline mission, which we'll get into in the details - But I still think this was a, you know, a horrendously big mission with a very large physical science payload as well as a very large life sciences mission. In general, life sciences ought to group their experiments instead of spreading them out over many flight opportunities. However many flight opportunities they get, they're going to do better to group them together into very large ones instead of spreading them out for several reasons. One is that you can compare data you get on one experiment with the data you get on another experiment. Like if one human being is the subject, you run him on one experiment, like the cardiovascular one, and you run him on the pulmonary ones, and you run him on the biochemical ones. You compare the data that you get there instead of flying them on separate missions where you don't have the same subject and at the same time. Also in terms of the crew, the discipline

training of the crew, that's another reason for grouping them together, as well as I still think a life sciences mission should be a single-shift mission instead of a two shift. As - well, yes all - Bob brought that up, I'll address the shift business. The life sciences subjects, whether human, rats, dogs, plants, amoebas, whatever, looking at what we've had in the last two sims, the subjects, if you shift their circadian rhythms, you might as well throw out the data. It's bad enough being on one shift. The data, and we've had some really fine level data on these experiments, you could see a tremendous difference whether an experiment was run at 9:00 or 10:00 in the morning when Chuck arrived, or run at 8 or 9 o'clock at night. The cardiac outputs are an example. Any time you ran them in the early morning they were running about 5 or 6 liters per minute on us, and there was some question as to whether they were valid. But any time those things are run in the late evening, we were running 8 or 9 liters per minute. That's a tremendous difference. And there was no plot, we can get the data's there, but these things were very obviously were coming to us. And we didn't have a heart rate readout, but if you look at the average heart rate at 8:00 or 9:00 in the morning versus 8:00 or 9:00 or 10:00 or 11:00 or we were even working at midnight sometimes, that data is really different, but you can flight-plan to have an experiment run at the same time each day. But if you get into two-shift operations and you shift a guy, you shift his circadian rhythm, and you say, we'll shift him 2 weeks before launch, but you know what things are like prelaunch. You can't shift a guy prelaunch because he's part of the integration process. And I just don't think we can go up to launch day with a crew working during the nights and sleeping during the days because the rest of the world isn't that way. So I think for life sciences - a mission that is very heavy in life sciences, we ought to be thinking about a single-shift type mission.

Now in terms of shifts, the way I look at this one - and, of course, other people can make as many contributions towards this discussion as I can - but the way that I look at this mission we'd have got more just looking at the package we had. We'd have gotten more out of it in terms of scientific returns, we'd have gotten a lot more out of it if we had flown it as a single-shift mission instead of two shift. In other words, having Bob on the same schedule, we are working 16 hours and sleeping 8, didn't sleep 8 very often, but they flight-planned it that way. I think we would have gotten a lot more out of it. And you could have

cycled one crewman, say he's the one that's going to - all the SAA's were during the daytime, it turned out those were the orbital characteristics, so we got all the SAA's while, it turns out Bob wasn't always sleeping when he was supposed to be sleeping, so he got some of them too - But my looking at the package I think we'd have gotten a whole bunch more out of the whole mission if we'd all been on the same shift. And every third night you can have one crewman who would wake up every 3 hours and do the monitoring function if they really wanted to monitor it every 2 or 3 hours. It turns out, when he was sleeping all we were getting were SAA's and monitoring functions anyway. In other words, we weren't - the payload was doing its own thing. So I think we'd have gotten much more out of this mission - we wanted to do it on this sim because we learned a whole of a lot, we really learned a lot. Having a two-shift operation is all kinds of problems that we knew were there before we did them, but we had to demonstrate them. How do you feel about that?

CLARK

I think we learned a lot about the two-shift operation, particularly in the traffic in the middeck and the habitability and things like that. But that off shift was rough; I never could adjust over to that sleep cycle. I tried - I started out the Friday before the test trying to change over and just never could change. What made it particularly tough was the fact that I was the only one up. If there had been a commander or pilot onboard, such as there had been somebody else up at that time, it may have made it easier, but I don't think it would have made a heck of a lot of difference.

MUSGRAVE

It's not as simple as just as, you know, down here when we've had the shift work in the mission control or something like that. There isn't anybody that ever slept through turning the waste management system on, there isn't one instance where that was turned on that a crewman didn't wake up. It not only woke you up, it rolled you out of bed. So that's another - it's a habitability-type thing we learned. The ambient noise level on the Shuttle is going to be much louder than what we had in here, so the impact of turning the oven or the waste management system on will be slightly less. But I guess I'll get into habitability a little bit later. But I think we've made a lot of contributions or pointed out a lot of problems of what we need in terms of - take a look at what the noise levels are in the ECS or the Orbiter - or what the noise levels - to really consider noise levels in waste

management systems and ovens and this sort of thing. And also to design the sleep stations with soundproofing types of walls, blankets, whatever, and - so that the crewmen can be pretty well cocooned. He could have his own ventilation, but he is sealed in from light and noise, as well as possible. So that shift is not a simple circadian shift, it's also trying to sleep when other people are banging around, and also, when people were sleeping in there. Now we perturbed our own operational schedule because we knew he was sleeping in there. In other words, we held off using the waste management system. Chuck and I were eating lunch - I guess day 6 we ate lunch around 8 or 9 o'clock at night, or something like that. We were out there running so hard we forgot it, but we always put off lunch when we was in there sleeping because otherwise we'd be groping around in the dark there. And we'd grope around in the dark and bring some food out into Spacelab and eat it out there. So you're not just going to bang around and when a guy needs sleep that bad. You're not going to bang around in that place and turn ovens on and do all that and wake him up when he's in real need of sleep. So we needed to do a two-shift operation. We learned an awful lot, but I think for this mission we would have gotten a lot more if we'd put everybody on the same shift.

The coordination of all the events that happened was absolutely outstanding, but the training office did a good - the coordination was really outstanding this time. The training coordinator is supposed to coordinate the training, but when you get right down to it, what the crew is doing and how the crew is meeting the PI's and the payloads and all that stuff, it kind of drives everything else. So I think it turns out that that's what coordinates everything, and it was absolutely outstanding this time. There wasn't a single incidence [sic] of when we showed up to have a training session on a given experiment - this time there wasn't a single missed event. In other words, there wasn't a single time throughout that we showed up for training that the PI wasn't there, that he hadn't been expecting it for days; that he wasn't there and ready. We had several instances last time where we'd show up at 8 o'clock in the morning for training session, and for three or four experiments that day, the PI didn't even know he was on. And we'd get on the telephone and try to regroup. The coordination this time was outstanding. In terms of the participation, the integration of the crew, I think it would have been, we should have had at least a

pilot on this - CDR/PLT, if you've got both of them there just isn't enough Orbiter work and you get into a situation where someone's just sitting there twiddling his thumbs because he's doing Orbiter work. But we could have this time, we could have said that like the commander does all the Orbiter work and the pilot will be available for payload operations. And we could have done that and the reason we didn't is - there were bodies available, there's engineering-type pilots you've got to come in and fly as a pilot. But I approached everyone in CB and CA - I approached them first of all to ask them, how much training would you want to dedicate if you are flying a life sciences mission. I said, I'm thinking about 100 hours; that's my rough hack at how much training a pilot ought to get toward payload operations. And I couldn't get any answers even on how much training. I said, well, if you don't like 100, it's 50, 150, whatever you all think, and I wasn't getting any answers. And that's really why we didn't have a pilot on this one because people were not - they wouldn't say how much training, they wouldn't say how much time inflight they wanted to participate in the payload. When I think - when we get down to flying, the commander and pilot are going to mean an awful lot in terms of payload operations. If you look at what Ben's got, the flight plan and do the maximum, a nominal orbital operations will be 5 hours a day. And that leaves a lot of time for payload operations. Now the BOP's just don't show them doing much payload operations. But, you know, what else are they going to do up there? And we need it, we really could of used commander and pilot types as subjects in the payloads, but also on several of them they could be good operators of parts of this payload.

CLARK

A comment on that. On our experiment, it would have been operationally much better to use the commander and pilot for the monitoring function and for the South Atlantic anomaly. The training that we used on our payload for Chuck and Story was like 6 hours at least, somewhere along there. Is that about right? Maybe smaller.

MUSGRAVE

Well, I don't think it's smaller, 6.

CLARK

Around 6 hours training on that payload. The commander and pilot would be on the flight deck and would be the logical ones to do that operation and it would have - the impact on the life sciences experiments would not have been there had a commander of our experiment - had a commander or pilot been in the simulation. And we could have

got more detail monitoring, we could have got more observation of the payload in flight if the commander and pilot had been in the sim.

MUSGRAVE

This brings up the whole question of, how you divide the labor between the crewmen? And you've got Baseline Ops plans that delegate pretty specifically what each person is going to be doing, and I guess you have to have them right now. But I hope that when we get down to flying, you throw all the crewmen together, and at that time you assess how good they are at different things. Now Bob was - once we got on into it, and we got a little training, we got a look at exposure, we got a look at - the same as last time - crew motivation, you could see talent arising in terms of getting exposed to these different payloads. And Bob, the physical science PS, he was prime on two of the life sciences experiments. Well, the BOP's doesn't show that. It isn't reasonable to make a physical scientist the prime guy, the systems expert, on two life sciences experiments. But his being a nuclear chemist - the cardiac output one involved radioisotopes, who is there better to do that, in terms of being the systems expert? And in terms of the stereometric photographs, those were things we wanted to get at the same time each day, the baseline state right after the first void of the morning. And his being up at night, he was the logical person to have all - both of those all set up in the morning, so that we could run out there and do them. Also, he participated with the PI, one of the PI's in that experiment, in photographing lunar rocks. It turns out he was a natural expert in both of those areas. I just don't think that in terms of - when you get down to flying a specific mission, I don't think you ought to legislate early on what everybody's going to do. You've got to let the crew shake it out, and you've got to let the division of labor kind of evolve as people get into the task. I think one of the major victories - in fact I don't think I've ever been so excited about something, I was yelling and screaming in there. I don't think I've been so elated that it was equal to any other thing since I've worked with NASA. When I - unfortunately, I was strapped to the table. You know, when something goes wrong, I like to get up and get going and get into it. And it hurt me to be strapped on the table. I couldn't go anywhere because I had wires running from everywhere. When the ground is saying they can't get VGX down there, boy these guys - Bob whips over to cardiac output and he's pulling B and C connectors off of that thing to make series and series to

get enough wire to go from the FR 1300. He's on that end of it. And Chuck's hooking it up to the vestibular CRT. This is to prove that we had a vectorcardiogram, so what's that got to do with vestibular? But the smarts were there, and in no time at all we told the ground, hey, it's there, we are getting it to the tape recorder. Well, so what's Bob got to do with life sciences? What is he doing down there working a malfunction on a life sciences experiment? That's the lesson, that you don't know who's going to be the expert and there's times - I mean he had it. The guys put it together and I'm yelling and screaming. It was fantastic. The speed with which that happened and to be using different experiments to come up with the hardware and the mixed discipline crew working together, the lesson was really there. And there's times we're going to be flying, commanders and pilots - We're going to have people like Bruce McCandless, who's equal to a Ph. D. in electrical engineering, that's going to come down there and be able to really contribute to working malfunctions in life sciences hardware. Or you look at any of the rest of the guys who are typical commanders and pilots - So you've got to look at each individual, I don't think you ought to legislate and lay the groundrules down for who's going to be doing what until you pull that crew together. And throughout the last test and this one, those kind of things were there.

CLARK

The way that particular malfunction was worked, I was down there. Chuck made the first comment, "Let's get some cables," and we started looking for that. It was Chuck's idea, he came up with, on getting the cables and starting to work that. And we just worked it together.

MUSGRAVE

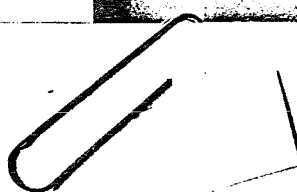
And likewise, if you look at the BOP's, what's the mission specialist supposed to be doing? Well, I'm supposed to participate in payloads at the discretion of the payload organization. That's what the BOP's says. In other words - So I suppose I don't know whether I had the discretion of the payload organization this time. But I really think we need to take a look at those kind of things. The mission specialist, he ought to be taking care of the waste management system, and the cooking, and the cleaning up and all of that stuff. The last day, I think it was - was it day 7 - I heard it all the way - I was back in the Spacelab, I was doing a chromatograph or something, and I heard it all the way from there. Chuck comes in and I don't know what the exact words were, but everyone looks

at Bob and he says, "My God, are you cleaning up after him again?" [Laughter] No, I was talking about the food on my tray and all the leftover bags and all that stuff. But it gets down to that there wasn't a single irritable moment throughout the 7 days. Everything went smoothly, there was humor, there was fun, there was play, there was laughter, and yet all the work got done, and it got done right. And the allocation of labor, it just shifted out to who had the time to do things. And it turned out Bob had his payload and command and he had a little more extra time, or maybe considerably more extra time than Chuck and I did, so he got more of the housekeeping-type tasks.

I think living in - again, this came out of the last one - I think living in was extremely important in terms - that it was particularly important this time to exercise habitability aspects, the personal hygiene, the noise of the two shifts, the food, and all the rest of that. But it's extremely important, I think, to find out what a man can do. You can work 24 hours a day, one day, but you can't do it all the days in terms of crew performance. We got up, we'd feel absolutely terrible, it was horrendous how bad we'd feel getting up in the morning. I mean that first few minutes was really . . . how bad we felt. But somehow, you know, we got going on things and within the first hour we were up and running again and feeling good. I don't know how in the - we got feeling so good from so bad, so fast.

SAWIN

It's a psychological thing that I've found between the time we did the 2 days of integrated tests and we walked out of there the night of the first day and went home for 6 hours, or 5 hours, or whatever it was, and came back and started again the next morning. You don't get in the swing of things like you do when you - the door shuts and that's it. You know you're not leaving the thing, the mockup, you're going to be there. And by the time we were into that 2 or 3 days, the air-to-ground communication was so realistic from my experiences listening on the ground during the Skylab, for instance, that you get psyched out to where, until somebody would drop a wrench outside or you'd hear the door shake due to the wind, you'd really feel for a time that you were actually flying and I think it makes a big difference in setting the mood of the whole test. You're not thinking about what you're going to do when you walk out that evening, or what your options are, because there aren't any. You're there.



And it helped. And I didn't like - that's the thing I liked the least when we were going into that test, was the idea of being caged up there. But I think it was most beneficial in retrospect. And one day about the third or fourth day into this test, Story and I were sitting talking and I said, you know, based on my experience so far, I think that an individual needs about 4 days under these conditions to run the payload. And he said, you know I figured that out a year ago. And it was an empirical thing that the amount of time required we both think is fairly similar. You have to have that experience with no one else walking in to hand you something, or do something for you, or interfering with your day. You need that amount of time to learn what your capabilities are with a given set of hardware. And it's just an empirical number, roughly 4 days.

MUSGRAVE

[Microphone being moved] - and it's also an efficient type of training. It's when you start running three or four payloads simultaneously, and that's the way you run. You've got something cooking over here, something cooking there, and you're running somebody on the cardiovascular or something else like that. That's mission training and how to pull the whole mission together. In a lot of payloads, they change a lot when you just move from running them in the lab until you run them in the module. Now all of you recall that first day in the cardiovascular. Well, it was going smooth in the lab, but we moved in there and we've got a guy lying on the floor and the wires are all draping over him, and you're trying to lean over him with one hand to - in that one-handed operation of the thing. You know, it's just different when you get inside the module. So you need training in the Spacelab configuration, and also you really need the mission training where you're pulling it all together. It's not like flying individual experiments, then you learn how to have things going in parallel, simultaneous. That's about what I have in terms of the total integration process, I'll hit training next then flight ops. I guess somewhere here you can discuss defining the task and crew selection, what it takes to fly this thing. As opposed to last time - The last sim we had a lot of and we didn't in Skylab - and the last sim we had a lot of it and that's biological art. The last time we had animals onboard that required tender loving care. We had a lot of microscopy. We had tissue cultures, we had sterile technique, we had - you had to be good with a microscope last time. We had the fish eggs,

we had the amoebas, and tissue cultures. In other words, there was a lot pipetting and things. There was a lot of biological art involved last time. There was certainly a lot of instrumentation, too. But this time if you look at - The way I look at the task involved, where did you really have to be smart? You had to be smart in bioengineering, bioinstrumentation, instrumentation in general, and data management. If you go in and you review the packages, what did it take to get the job done? It took an understanding of moving from the transducers through the amplifiers, the CRT. We were conditioning signals this time. We never conditioned signals before and we didn't condition them on Skylab. If the tape recorders were going, and you had numbers on ESS, which were good numbers, you forgot about it. That was an absolute that was designed into the system. Well, we were conditioning signals this time, and if they weren't conditioned correctly, they're off scale on the tape and you lost it. So for the first time, we were conditioning signals. But if you look at the total understanding of this job, I think the big things it took was bioinstrumentation, bioengineering, and data management, the central data stream. And I think if you look at where we goofed, and maybe where we were weak in things, these are some of the areas. Bob already mentioned we had four PDP-8/E's. You've got to know how to talk to computers. You've got to know the general logic, the flow diagrams, and all for computer operation, and I don't think that's peculiar to this simulation. I think it's something in the future. These machines have tremendous capability. Now, there will be some conditions, there will be some types of experiments, which will have a lot of biological art to them. But in general, I think this very complex, flexible equipment with a lot of computer interface, I think, is here to stay. So I think, in terms of who would be good on this type of mission - I think those are some of the disciplines that really ought to be considered. In terms of payload specialist, we still - we haven't yet, we've only been through two sims, but we still need to. Maybe it will happen. Maybe sometime. But we've only flown super payload specialists, we haven't flown any other type yet. And what do I think it takes? I think it takes still somebody who can - And I'm not in any science, I'm for getting the job done. I mean that's what we're here to do. We're here to run as many things as we can and maximize the output of the mission. It takes a guy who's smart, and it takes a guy who can run 16 or 18 hours a day doing

it 90 percent correctly. I don't think we're ever going to get away from that. You got to get a guy who's the guts to run all day long and do it about 90 percent correct. Obviously nobody's perfect. But that's something that I'm not sure people appreciate. You may have a guy who's a super scientist in his own area, but he's only going to do his own experiment. You've got to be a generalist in this business if you're going to fly 20 different experiments. And also he may not want to run 16 hours a day doing all these other experiments. So I think that was the critical thing, to get done as much as we did this time. Now somewhere along the line in these sims, I think looking at the selection process of payload specialist - It's going to happen in the future, and it's going to happen at one of these sims, that someone will get chosen who cannot run that length of time and run that hard and still, you know, keep his composure and do things right. So I think that will get exercised at sometime. Does anybody got any comments on that one? These guys really knew how to get with it.

SAWIN

When I was initially approached about participating in the test, I was pretty negative about it, as a lot of people would know, and for a lot of reasons some personal, some professional. One thing, I know Story well, and I thought it might be hard to play his game, but as I got into it I think we had good rapport, and this made it all come together. I learned what he meant by getting up, getting going, and keeping going as long as you could, and then just dropping it and going to bed. Well, you found out by the time you did that, you really were working about 16 hours a day and a couple of hours picking after yourself, and then what was left you slept. And his philosophy had been that in a 7-day mission you should be able to do that for a week, and I thought at the outset that wouldn't be possible, but it really became very easy. And I'm still not back down from that kind of a schedule because we were taking less and less sleep each night and not really requiring it, up until - of course, the last night we might have pressed it a little hard. Sunday showed we required it. But really, the point is that although I may sleep 7-1/2 hours a day, during the average week, I could get along quite nicely on 5 hours, really well. And we'd have a high and a low spot a couple times during the day, and you'd sink a little bit maybe in that long afternoon, but invariably each of us came back up and

felt really good. And I never felt any pressure, any strain, it just went smoothly. So I believe that, although I doubted that was a workable philosophy; in fact, it is. And, of course, it helped to have all the attention we had from everyone on the team, I mean that goes without saying, reminding you of things you might forget. Because I for one in my work habits am a person who tends to focus in on one thing at one time, and Story kept saying, we're going to have to get to where you can do several things at one time. It's a real change to try and watch two or three different things and that's where it helps to have the Science Manager always reminding you, hey, there's something you need to do in 10 minutes, or Flight telling you how you've got to go up and watch that cosmic-ray payload. But as long as everyone pulls his load, a guy can work very efficiently on a schedule like that, and it is not a strain. That's basically it, I think.

MUSGRAVE

Everyone else, go ahead and chip in your ideas on this thing. These are kind of our ideas and we're discussing a lot of things that we're not the experts on.

Training

MUSGRAVE

Moving into the training, it's something we didn't do in previous missions, we didn't do it on Skylab, but we've done it on both these. And that is the flight controllers are training with the crew, and this is really an asset, it really builds a team. You know the ground people. The flight directors understand what you're doing, they're empathetic with the task at hand. As you're doing something, they can visualize what you're doing and it really builds a team effort. In Skylab, we've had very little exposure to flight directors and flight controllers. In integrated sims, we would be talking to them, but it helps to know them as people and it helps to see the tasks that they've got. And it helps for them, in terms of their hardware and science expertise as well as building a team operation, to train together. That has worked out absolutely outstanding on both of these simulations. The training approach this time was about the same as last time. It's something that evolved last time. We didn't have a training plan the first simulation, it's a good thing we didn't, because we let a natural evolution of a training approach evolve. Starting with a couple of hours of just sitting down at the PI's desk and talking over the science. What are the scientific principles behind this

experiment. How can we maximize the return of these experiments? Then moving into a lab. Getting a familiarization of the hardware, watching him run the experiment for a while, and then we get where we're running the laboratory. Then some training when it's in the racks, then some training when it's in the Spacelab module, and then finally integrated sims where we're running it all together. I think that training approach worked extremely well. The amount that we had accomplished, and the accuracy which will come out once the data gets analyzed - we'll take a look at that later, but I think we were ready for this one. Probably no one in this room thinks I'll ever be satisfied that I've had enough training, but if we were flying a real mission I'd have want more. We'd pulled it all off, but everything went extremely nominal, we didn't really have any big glitches that required a tremendous systems knowledge on our part, or tremendous knowledge of the computer programs and other kinds of things. We really had an easy 7 days in terms of what we had to know about systems. I'd have liked to have been exercised a little more in terms - The ones we did have we pulled off gloriously, but if we had a few more I think we should have been taxed a little harder, technically. We should have had more technical glitches in there to find out just what we knew and just how the total team, the test ops team could have pulled those things out. I'd have liked to have seen a little more of those. In terms of the future, if you look at the Baseline Ops plan, the payload organization is responsible for training the crew on payloads. I don't think the payload organization can do that. I don't think they've had experience. Even our own PI's here within NASA, they still need some help in the training program. I don't think you can tell people from the outside at some university, hey, you're responsible for training the crews on your payloads. I think that they need some guidelines and obviously it's a sensitive area people think you're taking over their payload again, like we've heard in the past. But I think we've got to stand by to at least have a mechanism to assist them when they need it. Data during training is fantastically important. The data, that's the common denominator of how are you doing, how is the hardware doing, where is your proficiency. And this was true of the last sim, and it was true of this one. And for those experiments which fed the central data stream, we did not see any data on that until the Monday, which was 2 weeks prior to going to run. And that hurt us, not being able to see data. Because you look at the data and you evaluate how you are doing, what are my weak points,

what are my strong points. And so data is extremely important, it's a feedback to the operator about what he's got to do different. And it's a way the PI can say, hey, you're doing okay or you're not doing okay. And you know you're there when you can run an experiment end to end and the PI looks at the data and says you've got it all. So, it's not only important in terms of the training, but it's important in terms of evaluating the integration process and the performance of the hardware. So that was one thing that really scared me as much as anything else in this last 2 week push was that there were experiments that until we got to integrated sims, which was the week before, we had never seen the data we collected. So there needs to be some mechanism for looking at the data even in the lab before you get to integrate into the Spacelab itself.

MERRITT

. . . . Could you comment just a little bit, Story, on what you think? Maybe an integrated sims maybe a couple of weeks prior to that test would be helpful?

MUSGRAVE

Yes, the week before is just pressing it. Now I don't - looking at the future, I don't think we'll do it that way. I think you might well have an integrated sim in the Spacelab integration facility before moving to the Cape. And that's probably where your integrated-sim type activity would occur. Now the participation of, say, life sciences experiments in our Spacelab simulator, that's another way to go, and you might do it there. That participation, of course, is optional in terms of the payload, whether they want to go into our Spacelab simulator or not. That's another place you could accomplish the same thing, but I think you could accomplish it with the flight hardware in the integration facility. But just the moving to the Cape and the integration that's got to occur down there would dictate that it's a few weeks prior to launch.

CLARK

There's another point on that, and that is, we've got along super together. But I'm kind of wondering in crew selection in Shuttle when you're flying payload specialists and you bring in large dedicated experiments and you're integrating the team together, I think that an integrated sim is necessary, not just from the hardware and the operations point of view, but for the psychological adjustment of the people getting to know and work with each other. It would be extremely necessary to have that sort of integrated test for the psychological factors involved.

MUSGRAVE It develops a team effort - a team approach to the problem. Where you really know what people are good at and weak at and you really learn how to get along.

DELUCA Story, the one thing about that, though, is that the tendency today is to talk about loading and flying. And I think it behooves the people that are involved in this test, through their organizational level to feed back inputs that really emphasize that. Because the tendency is so much think that you're just going to load and fly and that's it. And the only way that becomes known is for several organizations independently, although they're part of the same test, is to come in and say those kind of things.

MUSGRAVE If nothing else, . . . it's going to cost you 25 million bucks to fly, and you ought to do what it takes to get it done right and get your return. But I guess it's a matter of impressing people about the importance of this team integration, both with the ground and flight controllers and amongst the flightcrew, and to develop this ops team. I've never seen better coordination and a better team effort than in these last two sims, and maybe you guys can speak even better than I can for it. I haven't seen it in actual space flight missions. I haven't seen as close a team between all the people involved, payload organization, flight directors, crew, and all that. I haven't seen as much coordination and as close a knit team as we've had on these two sims.

DELUCA That's because we're together from the start to the end. In the past, what has happened, it's been - in the past experience it's a 2- to 3-year effort. And what has happened is the crew and the checklist people have gone off and they have performed - getting things ready. The flight controllers have been involved with one set of missions while preparations for another one have been going on. And as a result, it wasn't until you got down to the last 4 or 5 months for the type of missions that we were flying that we really got together and ended up doing some integrated work.

MUSGRAVE It was integrated through - the electrons were being shipped from building 5 to building 30 and so was the voice. But a lot of times you didn't know the man face to face. And also you didn't know - And I scheduled a session this time on data and really on the POC, so that we could go in payload ops center, and we could actually

see the consoles, the people, and the data for each experiment that he could look at. So what can they look after us? In other words, how could they help us? What data are they getting down? Can they look at this thing and can we buy it off? Yes, they can buy it off, it's acceptable. And how much can they see in terms of what we're doing? So there again you build a team effort, if you know what their visibility in to what you're doing is. I think it's real important stuff. And you're right, it really needs emphasizing. I'm not sure we'll be able to sell it. I think it's - yes, load up and go. But we have to learn the hard way sometimes. Flight-type hardware for training, we trained with the actual flight hardware, and I think that's important. I think exposure to the flight hardware is important to learn the idiosyncrasies. There isn't a single machine that doesn't have its own idiosyncrasies. To find who the experiment-hardware expert - there wasn't a problem this time, it was pretty clear. Coming out of the first sim, there's times you didn't know who the expert was. There is a time the PI knows his experiment better than anybody else. There are times that the PI doesn't know anything about his experiment. He knows how to operate it, but he doesn't know the systems. There are other type technical experts. I still think in the future you need to define for a given experiment and even within an experiment for each module, who is the expert. And until you run into problems with it, it doesn't seem like it needs saying. But if you go to a university or some other place where this experiment is going to come from, it isn't always the scientist, it's the expert on the equipment. Sometimes it's the manufacturer, sometimes it's the service rep, sometimes it's the technician in the lab. That was true a lot of times. If you look over each of the experiments, you can analyze it very nicely for this simulation. Who was the hardware expert? Sometimes it's the PI, sometimes it's the PE, sometimes it's the lab technician. In terms of systems training this time, the amount of systems training we got was exactly equal to how many questions we asked about the system. In other words, it was our digging in, there were no systems presentations, there was the science, there was the "how to operate it," the control and the display panel and that stuff. The systems training we got was - once we got a basic familiarization, was our probing questions into what these things did. But I still think we need to get plenty of systems training, probably more than we had. In terms of training, I know there's a lot of other factors involved, but the sooner you get into the racks and the sooner you get into the Spacelab module,

the better off you're going to be, because some things do change. The stowage training again, the stowage didn't come on until - that's one of the later happening things here. But we did have a day before we got to flying that we could go in there and pull out every single drawer. And it happened the last sim and it happened this time. We didn't lose a single item. There were times when things were spread out all over the spacecraft and we had to hunt for them, but that's because we did it. That had nothing to do with stowage. We never had to ask the ground where something was. We never had to refer to the stowage checklist, I never saw it. You guys didn't see it, was it there, was it onboard?

SAWIN

It was onboard.

MUSGRAVE

I knew where everything was that I needed. But that saves an immense - this may seem like a picky, like a little nitpicky thing, but if you've got to hunt through a spacecraft to find things when you need it, you need it. If you've got to go looking for it, it costs you space flight time, it really costs you time. So if we've got a fully stowed vehicle that we can go in and go through drawer by drawer, and just look in that drawer and just etch in your head what's in that drawer, you can go get it. And you're running one experiment and for some reason you need a tool or something that's not with that experiment, it's over in some other guy's. You go over and borrow it, do your thing with it, and put it back. Stowage training, the only kind of real stowage training is a high-fidelity stowed vehicle. Training hours, the last sim I came up with - estimated that for a 7-day life sciences mission you need about 350 hours of payload training. And I still think that's a reasonable number in my estimate. I, of course, haven't been able to tally how much we got on the last one. But that's an estimate, and this sim hasn't changed my estimate on that. That's about it on training, the coordination again was excellent. Anybody else got any on training, crew performance?

BENSON

I have one question. It's - A minute ago it sounded as if you all were more less psyched out for the 7-day period. And if they had added another day on at the end, how would that have effected you?

MUSGRAVE

You could have added - if you had put something in the pantry you could have added a week. There's no doubt when you're peaking up for something, you peak up so high. If

you've got 80 days to go, you peak up, but the peak comes different. But I think we really hitched right on - about the sixth day I think is probably the best day. Where we were laughing and joking and we ran through every single thing, there was only the nine left to run. We ran through all eight special procedures, we ran every single experiment. Nine takes an awf - That's a 4-hour job, it's hard to dovetail it into the other stuff. So we didn't run that, but we ran every single experiment a bunch of times, and we were laughing, joking, playing the whole time, and still doing it right and doing all of it. And that's - We could have stayed right at that level for 30 days. I think - -

SAWIN

We talked that over and that day - that night. Again I said, you know, when I initially came in here, I really didn't like the idea being locked up for 7 days. But at that time - It's part of the psychological thing I was saying about being actually in the facility and not being able to leave and knowing you're not leaving. At that time, I felt no strain or stress. We were kidding about well maybe we will go a little longer. We knew we wouldn't because we'd run out of consumables.

MUSGRAVE

Yes, I think we could have. We could have stayed right there. If you're going to do that, we need to exercise. You're robbed from sleep according to how long you've got to go. We couldn't have stolen that much from sleep for 30 days. We'd have to back off a little bit on that. But the nice thing about locked up in there is you're not cheating when you steal from sleep and housekeeping; you've got to do it some time. And you use cleaning up as a time buffer; you may not clean up for, you know, a couple of meals. The place gets to be a real mess because it's busy back there and you're running things. But you can't not clean up for 7 days, the dishes get really high.

DELUCA

Would that peaking - the position of that peaking be different if you had more, if the presims were a little bit longer? Do you think that would change that? Would that be - -

MUSGRAVE

You could get there faster, but even on day 1 I really felt good. The first sim, it was the end of the second day I knew I was there. We were still OJT, we were still learning on the job in that first sim. About the end of the second day, we got there. Even day 1 this time, it just went smooth. I don't know why. But again going back to

what I said before, I think that's - You're all getting a good feeling for what it takes to do the job. I don't think every person can do it. I don't think even with the super training we get in this whole developmental method we use in getting people ready, I think there are some people that can't do that job.

QUERY

Story, could you compare your performance, during this simulation in the one-g environment to what it would take to do it in the zero-g environment, and, if so, could you envision incorporating the zero-g exposure procedures in future sims?

MUSGRAVE

It's like the last one, we had some zero g. We had maybe half of the first sim were - experiments were zero-g qualified, and all the techniques and restraints, they were zero g, some were not. In comparing, looking back in the Spacelab, I think we came out even and not including anything else, just include the Spacelab itself and the ops back there, I think some things zero g would have hurt us, but they definitely would have helped us on others. Like moving that chair - [Laughter] We joked about it 100 times that the second the flight directors tell us it's over come out or they come in, we were going to open the aft door and throw the chair out. [Laughter] That was a heavy moose and there's no wheels and the carpet as you know was laid down in blocks. And when you go to get the chair the one guy is wired, he's got wires coming out of everywhere and he's captive, he can't help, one guy's got to grab that chair and there's nothing to grab it by. There's many other examples, but that's one. And you drag that across the floor, there's no place to pick it up and you're tearing the carpet up and it's rolling up underneath and finally you get there, you drag all these endless umbilicals and that's a place where one - zero g, you know, . . .

. . . There were places that one g hurt us. I look upon the whole thing in the Spacelab as coming out even. But you've got other things that affect crew performance, like motion sickness and other types of things. And I do get some criticism in these things of trying to get the most done. There are some people that say, hey, you ought to play the game that this is a real space flight and you would not be this efficient. In other words, at zero g and a lot of other factors, you wouldn't be that efficient. And there is a point to that, that in terms of establishing inflight time lines, you should not establish inflight time

lines from performance in this type of sim. It gives you an idea. But on the other hand, when you - the reason for doing these is to learn things. And the way I look at it, if you don't exercise something, you don't learn anything. If it isn't operative, if it isn't done, you can't learn anything from it. If an alternate experiment is never operated, then you haven't exercised the training process, you haven't exercised the integration process, you haven't exercised the thing at all, it's just dead. So that's kind of a philosophy, but you can't establish inflight time lines. There's places zero g would have hurt us, and there's places it would have helped us. The stairs is another one and the ladder going up into the - that would be a piece of cake, floating on through there. So - But there's a lot of things - the food system was entirely - that could have been done zero g like that, and then the waste management system was zero-g qualified, a lot of the stuff was pretty close to zero g.

Flight Activities

MUSGRAVE

Okay, moving on to flight activities and stuff, the basic flight plan came from the ground, — [Break] The flight plan came from the ground; the flight plan was absolutely outstanding, Ben, it always is. We weren't able to give Ben any really good time lines, because on all the payloads we really weren't there until about launch date. And unfortunately, on the cardiovascular ones, like we extended him, from I forget what we went - we had to add to you from 4 hours to 5 hours for back-to-back runs on both of us. It turns out we shouldn't have done that, but the thing is even the week before the week integrated sims were, we were still in there developing methods, how to string the wires, how to get things on. We got the stretcher in there instead of lying them on the ground. In other words, we were still developing methods because we got in the Spacelab itself late. If we were getting there a week early or so, we could have gotten Ben some better time lines. But, there's a lot of talk about the flight plan will come out of the general-purpose computer on the Orbiter, and the flight plan ought to be done onboard. I don't think it ought to be done onboard. The flight planners - the best flight planners in the world are right here and they can do a much better job on the ground than we could do onboard. They know all the constraints of this thing's got to be run at this time of day, it takes so long to do it, and it's got to be run

after this one or before that one, all of those things. I think the basic flight plan ought to come from the ground. It's an extremely important function. We didn't get much credit for real-time onboard flight planning. When you read the documents, we didn't get much credit for that in the last sim and I don't know how much credit we'll get for it on this sim, but we did a heck of a lot of it. We were a lot of times, 2 hours ahead of the flight plan or at least, I don't think we ever got very far behind it. But we did an awful lot of real-time flight planning. We always kept people very well aware of where we were. We asked permission to do something; we said, "Hey, we'd like to crank up this now," or "I'd like to tackle this right now." We did an awful lot of dovetailing and shuffling around, we'd do things in the evening - that were scheduled for the evening, we'd do them when we saw a little time open up in the morning. There was an awful lot of shuffling around. For the real-time flight planning, it's very easy to do it onboard, you know what it takes to get the job done and so you can see 20 minutes of free time and you can shove something in there. So I think the way we did it this time, the way we did it last time, is really optimum in my opinion. The flight plan ought to come from the ground, but you ought to have enough pad in it to do some real-time onboard flight planning. I think that's the way best way to optimize things and get as much done as we got done.

CLARK

One of the main points on that, is that Ben attended all the training sessions and had a real good feel for what time was involved in each of these experiments. And that helped immensely in the flight plan.

MUSGRAVE

Ben didn't miss a single training session. In other words, he was a technical expert on things as well as knowing just what it took to get the job done and having empathy to understand what you were going through running that thing and what it would take you to be running something else over here at the same time. And I'll - I'll get into procedures right now. After the last sim, I recommended that for a couple of mission days that the mission specialist do total flight planning onboard. In other words, come up with the next flight plan. If you asked me to do that, I'd say go with the ones we launched with prelaunch, because I wouldn't want to spend the time sitting down and working out all the logistics. And when you get into that flight plan and it gets into scientific priorities, it gets into all of that business, it gets into looking at

the real-time data you're getting, how should you change things, or something for the last 60 days it hasn't changed and you know it isn't going to if you need to run that often. So it gets into all the scientific priorities and logistics and everything else like that, and I think the ground could do a much better job. In terms of payload procedures, they were absolutely excellent. Absolutely excellent. In coming out of the last sim, the same thing, they are absolutely essential; the day is not going to arrive when we don't need them. And again, and I said this 100 times, if I sound like a tape recorder, just those of you that heard me 100 times, turn it off. We don't need them to cookbook things. We got there running those cardiovascular ones and other experiments, which are extremely complex, which - where we're conditioning signals. What you've got to do is discrete and it's got to be done right. We ended up running those guys, and the only thing we were looking at was the data log that we had to log in the data book, so that the computer that's looking at the tapes could extract the data off the tapes. The only thing we looked at was the data log because we had to write down the time that we started the tape recorders on each of those experiments, where the time we were putting the calls in and that kind of stuff. We ended up running those with only that. The reason we could do that is because we had good procedures. Procedures that are not so that you can cookbook something, but they defined the tasks, they tell you what you need doing. And they're also somewhat a description of the system, a description of the experiment, it's a baseline. They're also important because the people whose payload you're operating, the PI's, the payload organization, it's an agreement between you and them how you're going to operate their payload. I mean they own it, it's their payload. And so the flight directors, flight controllers, anything else. It's - in other words, it's not a solo operation, it's a team operation and flight procedures, it's sort of an agreement about how things are going to be run. There's a lot of different ways to run them. That's what procedures are there for. You need them to learn the task, not so you can cookbook something. We ended up by day 5 or 6, we weren't using procedures for hardly anything. But they're absolutely essential. Now if you look at the BOP, I think the BOP implies that the payload organization is going to come up with flight procedures. They're responsible for telling you how you're going to do it. Even looking at our NASA PI's, they do not know how to come up with a set of flight procedures. Some do and some

don't, and I won't pull out any examples, but you can all smile because you know which ones they are. I have got for each experiment - I've got the first set of procedures and I've got the final set. And it's astounding that - the change of procedures from the first, the one pager you get. The first time you get it, you know, it says power up the equipment, the next one says assure appropriate signals, the third step is take data, and that's what you've got when you ask for procedures. Well, you know, it doesn't let you get the job done. It doesn't define the task. And for that experiment, there's a rack this high and there's at least 32 knobs on it, but, you know, assure appropriate signals. Well, it doesn't define that task, it doesn't tell you what you need. And so for each of the experiments - my ring around my office up there - I've got the beginning and I've got the evolution of where we started and where we ended up. And so I think, there's a lesson in there that NASA's got to help payload organization with defining their task and developing the procedures. Because even within our own house here, people can't build them. There is an expertise in that and we've got to stand - For some people, boy you don't need to have any help; you ask for it and it's there. And you know, we all know which ones they are. You ask them for them and here they are. We've got some that didn't change a bit; we've got some that just hardly changed at all. But NASA's got to stand by and have a mechanism to help the payload organization define their tasks and get ready.

LASKI

You know, for the next sim, I'd like to perform a service for whoever you assign And to allocate ourselves some time with the PI's, whoever they're going to be, and say we are a service organization and we're willing to help. Now this is what we've learned, if you want to use it, fine. If you don't care to use it, that's all right, too. And tell them that we have a we have procedures. Give them a background, some examples, here's a good one, here's a bad one. We can make cue cards for you. We can make decals for you. We can do all these things for you. Just ask and we'll And I think that's where we were deficient in this last sim in the sense that . . . we did not service these people strong enough with our capabilities that we can perform with them. I hope to remedy it next time We should say, okay now, we want 2 hours with each PI or else start off a general with everybody. You know, anyway you want to do it. That we want to perform a service for everyone.

MUSGRAVE

You need kind of a user's guide type thing.

SPEAKER

It's nice to write things on paper, but to actually do it, on a personal to - person-to-person basis . . . , but you have to write it down.

SAWIN

I think your comment can be more generalized. It's very appropriate to what you're addressing, but it in the general sense applies to the total simulation procedure or real flight. That is, that one of the great lackings from my point of view, and I guess in this sense I'm a little unique since I'm supposedly a PI, as well as a technician for everyone else who was a PI - That is that I felt I knew what I had to do because I had played both games before, a little bit, and I had a good understanding of what my tasks would be. However, I felt that the PI's in general weren't given much direction as to what they would be required to do, what was expected of them. And so I see a need for some sort of a document - You know, we always keep bringing up the need for more documents and everyone says why. But something that would go to a PI and would say, in order for you to have an experiment put together and performed successfully during a test of this nature these are the basic milestones you need to meet, and here's some points of contact to help you, like yourself and Ron for procedures. And to kind of get him an idea of what he is expected to do, not that he just delivers a piece of hardware and says, okay guys, you know, run my experiment. Because as Story said, even our own in-house people, of whom all of us were, didn't know precisely what we had to do, what our responsibilities were as PI's.

CLARK

Then you're talking about things we mentioned earlier. It's a preparational, accommodations document of some sort with total operational procedures.

HUFFSTETLER

Yes, well, one of the things that we had wanted to do and weren't able to do, that was to get the PI's in prior to the test - George and Ron, and let them run through the procedures for themselves in the Spacelab. We weren't able to do that because of a - -

SAWIN

But it isn't just that, Bill. You know, it's a more general problem of a the PI says, yes, I've got this great thing I'd like somebody to do for me up there, and he doesn't know really how to go about it. He needs more direction, I think.

HUFFSTETTLER That's the reason we have them inside. I think we're going to do that now after the If that'd been done prior to it, prior to the test, prior to the establishing the procedures, they would do a He asked me to be familiar with what's going on Loop and traffic patterns things like that or do you want ? It has to be a part of our overall procedure

MUSGRAVE The real core of the matter is real discipline and the attention to detail. And start there and say here's the hardware, here's my experiment and I'm going to start through it, and I am not going to touch anything or do anything unless I write it down. In other words, what's it take to get the job done. And so many times, boy, we're just running there, and you run right square into a wall. The PI's there and his hardware is there, and he doesn't know quite where to lead you or what you ought to be doing. In other words, he hasn't really defined his own task. You've got something, Dennis?

MORRISON I was going to suggest that do you think this could be accomplished by both an introductory session and . . . have the PI . . . observer either during the sim or actual training . . . a combination of leading them into it with an actual introduction and then the guidelines to give them an idea on what to expect, and then let them see it in action. I think that combination would accomplish the job.

MUSGRAVE It's another sensitive area, though. It's like the payload will do the training. It's a sensitive area; people say you're taking us over again.

LASKI No, what I'm saying is that we perform a service. And if we're going to be a service organization, just like Pan Am or some airline, and I think if they understand it that way, and say these are the services we can give you and it's up to you to take advantage of it. I don't know if you want to say requirements.

MUSGRAVE No, you don't want to say requirements.

LASKI That's what I'm saying. The only other word I can think of is . . . the service organization, we always have in the past.

HUFFSTETTLER I don't think there will be any big hassle. The way you understand something is to do it yourself. Get the PI's

in there and let them go through the procedures, you guys leading the way. They run through the procedures, they know what the impacts are, and then go through this . . .

MUSGRAVE You can't tell them you're leading the way, though.

SPEAKER I mean as far as formatting, things like you're talking about where you put the book up when it said something about "Assure proper readings on the display," or something.

MUSGRAVE Appropriate signals.

HUFFSTETTLER - - proper reading should be.

MORRISON The life sciences have sort of the same kind of problem when they take biological experiments to a reactor facility for the first time. They don't know operationally what is going to be required, so they have an idea they're going to have to . . . about it. But it's a whole set of operational procedures that they have to put in, and bring them up to speed is usually the big problem in getting the experiment to . . . facility. And any of them . . . , . . . , whatever.

MUSGRAVE It's just something to recognize. If it's going to happen in the future, you have a mechanism for handling. Integrated sims again, that's a final verification that they got good ones. That's the high-fidelity environment where everything's there, and if the procedures work then, then you know you're there. But anything short of that, you can't be guaranteed that you've got good ones; and, of course, the data is the common denominator for the payloads. If you operate those procedures in integrated sims and the data's good, then you're there. Schematics of the flight hardware, maybe - Lou, you got something to say about that? I think there was only one experiment I saw a schematic of. It didn't hurt; we got the job done. There were times, you know, if something goes wrong, you'd sure like to see one, but obviously we're not going to have the FOD schematics we've had in the past. They might just have a manufacturer's handbook like we had for the GC or something else like that.

DELUCA I think what we foresee is a case where, for Orbiter and Orbiter's facilities, we'll have all the things we've had in the past because they are repeatable and useful to

produce. Same for Spacelab, and I think for core equipment, we should have the same thing, but when it comes to what is in the rack to keep the cost down, I think we will have to go with whatever is available commercially or whatever the PI will provide, and we'll have to rely on him for real-time help.

CRESS You're going to have to have interface, George.

HUFFSTETLER We're going to try to take care of that problem. We recognize that the schematics are necessary and . . . worse when you start getting outside.

MUSGRAVE I don't think you should insist upon - -

HUFFSTETLER We're going to have to provide the NASA support of all of this to an outside PI, to an outside contractor.

MUSGRAVE But I don't think you should insist upon - you don't have to insist on schematics.

DELUCA Our plan - I think right now our plan is not to insist - -

HUFFSTETLER It needs to be done - It needs to be done more than likely by ourselves, by our intern - our NASA people.

LAFFERTY I feel your best bet in that respect is to have the PI or PE or knowledgeable person sitting there in your back pocket while you're flying

SPEAKER

DELUCA I think what I would like to say is that when you have the equipment that flies - To me the point is if you fly, time and time again it is worthwhile to go through the trouble to having the kind of things we've had in the past, but when it becomes one time only, the man-hour investment - It may be questionable. And therefore, we have to rely on the easiest thing to get ahold of and we would not spend man-hours developing flight control schematics for flight-unique hardware.

MUSGRAVE The ground support was absolutely excellent this time; it just - it couldn't have been better. Both the mission control and the POC. And Carter did a super job of being a Science Manager, a science - what you might call a science CAPCOM. We're getting away from CAPCOMs, but the recommendations I came out of the first sim is that

you got someone that takes the place of a CAPCOM in the POC. He's the guy that's seen enough of your training, and seen enough of the hardware that he knows the hardware. He's empathetic with the task that's got to get done, he also understands the science, and he's also good interface with all the PI's and the payload itself. He did a really super job and the scientific support was fantastic. We always kept people abreast of where we were going next, so they'd be available and the way we were followed on the ground was really extraordinary. You could forget when you started something and you asked, and sure enough they knew exactly when you started it. So the support there, the awareness and the alertness, and the way they followed us on the ground was really extraordinary. They really knew where we were. We kept telling them, but they could have, you know - The tough job is really on the ground. The flying's fun and the ground is a lot of work. So everyone really kept aware from step to step of where we were. This raises the question of TV; TV was a fantastic asset, and it's something we ought to tell people how important it is. I think we'll have a hard time selling it. It's a very important asset not just in terms of the data, of the contractile protein, the amoebas, the fish eggs, the tissue cultures or whatever else but operationally it is extremely important; the TV is. We got helped a number of times, by really focusing that thing down, zooming in, and letting the ground see the way we're doing things. They could follow where we were. They could even hack the clock on time-critical items and remind us when the time came up. They could look at the way we're doing things and sometimes help us out; give us a more optimum way of doing things. I think TV is really critical and the more TV we can get from a life sciences mission, a Spacelab mission, the better off we're going to be.

QUERY

Are you saying color TV or just TV?

MUSGRAVE

No, I'm talking about just plain TV, no color TV, of course - The monitor we had onboard, we were seeing much better. We didn't have a color monitor so we were seeing much better from the little black and white, the Sony. But I guess - But most of the time the ground was asking for the color, so apparently you had better resolution on that one. In terms of a data device, the microscopic TV, and that sort of thing, the color TV is very important. And I don't know if that's been resolved yet, we've asked for - Well back at the PRR Spacelab I've put in strong

input to get color TV. Lou was working that, too. Do you know where we stand on that? The capability's there, but they're telling us we were to get black and white.

DELUCA We still have black and white. The point is that the communication system can transmit color TV, bandwidth error and all that. The onboard monitors are still black and white.

MUSGRAVE So, that's acceptable. I don't think that hurt us.

SPEAKER: So, that's really a function of what can - -

MUSGRAVE But, is Spacelab going to provide color TV for downlink? Their book says black and white.

SPEAKER Their book says black and white.

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McCOLLUM Nothing should prevent us from providing our own color monitor or camera in the Spacelab.

ALEXANDER That's right, but that would be in the payload. That's payload-provided.

MUSGRAVE I think you all can address it even better than I can. I think it's extremely useful.

SAWIN Are you still talking about the team or where are we on this?

MUSGRAVE We're talking about TV still.

SAWIN Okay.

MUSGRAVE It boils down to a team option.

SAWIN Okay, if we're going to have TV, could it possibly be remote controlled? It's not necessary, it's a frill, but it's very beneficial. The ground wants to see something, and the crew's busy doing something. If it were remote controlled, it would sure save time and talk.

DELUCA On the aft flight deck, we have the capability of going out and performing all the usual camera functions we've had in the past via remote control.

SAWIN It would be nice in Spacelab.

DELUCA The Spacelab, the way it works out is that if the camera is of the type that it can accept the remote control, the capability is there, because the remote control - The remote control command functions are sent on the sync line which exists. So the point is that capability is there.

WHITE Story, don't you think, though, if we'd had a commander and pilot, we'd have used them for that instead of having to break into the science . . . ?

MUSGRAVE To direct the TV? We've got - I guess I differ a little bit from Chuck; I didn't mind pointing that TV at all. Last time we had the remote and I didn't feel, you know - I didn't feel like it constrained me at all. And I just incorporated it in the way I did things. I'd reach over and grab that thing and aim it where I wanted. I'd just send you stuff that you didn't ask for; I'd just grab the camera and send it there. And, you know, it would come

on down. So I didn't mind doing that at all. Now I was glad - I was glad we didn't have the X, Y's and Z's, the f/stops and all the rest of this stuff; that would have eaten our lunch. Now Skylab, the TV for every single experiment, for every medical experiment, you had a place you had to take the camera, you had to triangle the marks, you had to gimbal angle X, Y, and Z for each thing, and f/stop. And you had to go through all those numbers and it ate your lunch. This thing, you grab the TV camera, you put it where you want to put it, you aim it at what you want; in other words, you're kind of the TV director. And I think we did a pretty good job of keeping that TV going.

DELUCA

And I think what is happening here is that is a function of the comm links you have, whereas in Skylab we were limited with a single link doing the things. The objective was to get everything set up with a minimum amount of necessary comm. But given the condition we've got, it just may be that you want to observe something slightly different this time than the last time and . . . there's really no problem . . . an influencing factor on that. The loop you have allows you to get back and forth much easier. Boy, Skylab, you know, just to come out of the room and say, we want to move it, you've got to go up to the front room and then you had to go to FD, then you'd have to go to CAPCOM.

SAWIN

Another suggestion, then, would be to have a portable restraint for the small, handheld Sony-type camera on each rack so that you could quickly position the camera on a strip chart or on a transducer, and the case of what we did for troubleshooting on a CPU, the computer.

MUSGRAVE

It would go on the handrails, most likely.

SAWIN

You'd walk over and clip it on with a minimum effort and get it focused in on what you're looking at. The TV worked very well, I thought, I mean from what we could see. The only thing, Bob was addressing about the function of the commander and pilot would be in the switching up in the aft flight deck. That that would be beneficial, what you're downlinking and which camera you're putting up on which monitor. We had to run back and forth up there, but we didn't do that too much.

DELUCA

Along with that comes the zooms and, and the light control . . . He could take all - he has all the controls to

optimize the picture. That's what that position will do. Now, locating it in a different position, once you get it hooked up to a control box, then setting it up like you want on a transferable mount, that would be the function down in the Spacelab. Given that, he could optimize the picture onboard.

MUSGRAVE

We may be getting into too much detail here, but the comm - a wireless comm would have been outstanding. Those things ate our lunch this time. Didn't eat our lunch so much the last time, but we had so many umbilicals running in so many directions that not having a speaker box down there ate our lunch. But also, if we'd had wireless comm we really would have been much, much more efficient. Dragging that - another umbilical around. And most of the time Chuck was operating, just talking in the mike hanging around his neck and using the speaker box. Wireless would have been outstanding. Again, the ground support was fantastic. It absolutely couldn't have been better. It was perfect and it was probably a result of the team integration, the team approach to the mission. It started on from day 1 the same as it did the first sim. We had a team approach through the whole thing.

SAWIN

I'd like to compliment everybody really. There was no weakness that I perceived or anybody that I'd like to see doing a little more; everyone was just great. And it was particularly nice with Flight and Procedures and everyone that I knew who was there. And I realize that this probably won't be the case, during real Shuttle flights when they bring in a PS from somewhere else and he just maybe shakes hands and says hello and then goes and does his thing.

MUSGRAVE

Yes, but he ain't going to get the job done that way; that's something we've got to emphasize.

SAWIN

It's really nice. Like when I'd call Science and Carter would be there, they knew what was going on, and he had suggestions, I knew what he knew, and there was personal rapport, which is very beneficial. Rather than just calling some function, some person who is supposed to know something about the area you're interested in. See, that's all part of the team effort, which is very, very nice; to personally know and have worked with each of the people that you ended up talking to through a black box. It made it much nicer.

MUSGRAVE

The difference is - You know the North versus the South football games. Who watches them? They're some of the poorest games going. You've got a bunch of scattered individuals that have been thrown together for a week. Well, that's not the way we ought to play football; we ought to play football with an integrated team. That's preflight activity, flight control, payloads. Data availability again is a common denominator extremely important for everyone. As soon as they can get to see in that data they know how they're doing. Visibility and accessibility I think came up again; we had a fantastic-looking lab but we didn't have that visible. You couldn't see into things. And the accessibility - again, we're not supposed to fix things up there. If it breaks, we're supposed to bring it home and fix it on the ground. The guy who's paid 25 million to get there, he's not going to take that attitude; maybe before flight but once you get flying, if it's one little pot you've got to get after or if it's one little thing that needs ink in it because the pen won't write, you're going to go do it then. It only costs you 5 minutes. So we need to be able to get in behind things. We need components that you can pull out and get to. There's so many things that there's an easy fix to. We fixed a bunch of things last time and fixed a bunch of things this time, by having access.

SAWIN

I think that the cosmic ray payload of Dr. Clark's, Dr. Golden, is a very excellent example of how one can use a digital computer efficiently and effectively. And by that I mean, as opposed to our use of the same computer, to know that we had gotten our data required my being there because we had no downlink telemetry of any sort, whereas they had 100 engineering parameters going down and they could be panned and surveyed and one could say, yes it looks like it's going all right. So, in my instance, what I learned is that if I were having somebody fly my experiment using the same computer that I am, I would be darn sure that I had provision to downlink some critical parameters just as we did during Skylab, so that you could tell whether, yes, you were getting about what you wanted or, no, something was terribly wrong. You need a capability, many times Carter or Bill saved us by saying we're not seeing such and such a signal that should be there if you have the right patch panel in.

MUSGRAVE

On the qualitative aspects, all of this data is qualitative. How do you like it? And without that capability,

you'll never know that; and you'll get home with your little tapes and disks and you'll go "Oh, God."

MUSGRAVE

We have been moving toward - Most of the payload people have been moving toward having their own onboard data collections system and not going for telemetry. And there was a pressure this time put to exercise a central data stream. So it was done, but we really benefited tremendously by sending stuff to the ground. So I think maybe that needs to be reassessed: how much stuff you're getting going to the ground. And if you are sending a lot of numbers, it takes a lot of crew time to get those numbers and try to extract the important numbers and send them to the ground and ask them how we're doing. I've got a lot of stuff here but I don't want to get into too much detail.

After the last sim, we had 13 experiments and I said, looking at these 13 and the excess stowage we had, we should be flying 20. And that's what I had put into my test report. The last one we flew 20; we had room for more. In terms of crew time, we also could have flown a little more. Sometime we're going to fly a mission that we don't get it all done.

The workbench, I guess that's a Spacelab thing. The Spacelab workbench is absolutely critical. That was fantastically important. It was full enough that you didn't have a lot of those shelves you could pull out, and the experiment rack here and a bunch of shelves here, and a bunch of shelves there, to get your work area. A lot of those things took a big work area. In zero g, they're going to take even more space because they need all the necessary restraints and that stuff. So for life sciences mission, that workbench is absolutely critical. You grab all the bags, you go over and push it down, and you'll hang things - test tube restraints or whatever else - all over that thing and then you get ready to run. There's so many examples that you saw there: the dash 11, the APS and the GO, doing all the rotors, handling all the blood. Lay it all out there. You saw it laid out for the dash sixes, the rats. Lay the whole thing out, get it all ready and off you go and usually it's the layout and the prep that's the important part. It took much more time. You know, lay everything out and once you get the production line going, she really goes. Something like a laminar flow bench that's baseline for the Spacelab; that is really important.

HUFFSTETLER Is there anything you would add to that workbench?

MUSGRAVE Well, we're one g-ing it right now; you really need to take a hard look at the zero-g operation. You can take those experiments, the ones we flew on the last two sims, and look at what's baseline for Skylab and exercise in your mind, mentally and on paper you could exercise: does that workbench fit the requirements of these experiments? For one g, for right now, it's neat, but it is one g. But that needs to be an exotic thing with real flexibility for on-orbit stowage and prep. That thing is really critical, and that's a Spacelab input as opposed to payloads. I've got a bunch other details and things on payloads but I don't want to get into quite that much detail.

Spacelab, Bill, you might try weighing this payload, if you haven't already. It's a recommendation I came out with the first one. We're looking at the total amount of power, we did a thermal analysis last time on how many Btu's we were pumping and that kind of stuff. You might weigh this payload when you take it out, if you haven't already, to give us an estimate for this mission, how much weight did we have on there? I don't know if that's a constraining factor, I don't know if we were approaching it, however many we're allowed. But that's another input we could make to Spacelab.

BENSON On flights, I guess the c.g. is important . . . balance.

MUSGRAVE Yeah. Those weren't necessarily Spacelab racks, you know, the problem with the drawers. But that's too much detail; we won't get into that. But there are a lot of Spacelab contributions which our detail will get into later. Lights, ECS, and that kind of thing.

A little bit on core equipment, I think the multiturreted microscope where you can view it, you can take motion picture photography and downlink TV, is a really good thing for life sciences mission. The color video. A bunch other things that, just to hit a few ideas, the diagnostic oscilloscope, oscilloscopic cameras, multimeters, those are some of the ideas, but I don't want to get into that much detail.

Radioisotopes, holding and handling, now that came out of the last sim. I recommended we need a mechanism for putting on radioisotope and the 15-A, the cardiac output, all along we just got there too late when we got to them and

started the training they said, well, gee, we didn't think we were going to do that and I really pushed to do it for real, where we were really using the radioisotopes. And I guess it got down to, that particular isotope they wanted to use was - that we were not an approved handling agency for that.

CLARK

Didn't have a license to accommodate that.

MUSGRAVE

But that's something. Radioisotopes are a super tool for really getting down to fundamentals of biology. We ought to have the same license any medical center does and we ought to have the mechanism for any radioisotopic study that wants to be done to date; the mechanism's there where they could come on in and do it so we don't run into that kind of end. It was a problem this time, we just couldn't add it. Now if we've gotten to the PI earlier, like a month earlier we had a training session, we could have pushed for the real thing and maybe they would have had time to get it on. But that's the kind of thing - we need that mechanism. It's part of core, that, yes, we can do all that. I'll just wind it up here.

Facility

MUSGRAVE

In terms of the facility, we had a fantastic facility there, the whole thing was. The Spacelab facility integration process was really neat. We exercised a lot of parts in terms of the habitability, the waste management system, it did crump, but we certainly did study the concept. Both the BMS and the WCS, I think we made a lot inputs. I pointed out a lot of problems, not really problems but things that needs looking at, noise, lights and that kind of stuff.

We're getting into too much detail. The trash system, you know, it sounds like a little tiny little thing, but it's massive. The trash system's got to work. The wet trash system there is absolutely essential. Now Spacelab is required to provide trash, say, for a life sciences mission, they're responsible for trash. What have they got now? They've got bags. What else they've got? Nothing. And if we're going to have the kind of waste we had on this mission and a backup waste system, they probably need to take a fourth of a rack, in other words, if you look at the double rack, they need a half of a half of rack, and have that as a trash system. Maybe they'll

vent it to vacuum; maybe they'll have a very mini Skylab type - or something like that. But trash is really important. And for life sciences particularly the wet type trash. And I don't know how big the Orbiter one is or its exact characteristics, but it's something for this type of mission needs looking at. It may sound like a real smally but, if you don't have a place to put it, it gets very big.

We'll hit a lot more details this afternoon. And this afternoon we've got, what? A couple of hours. I'd like to see a lot of more people do a lot more talking because a lot of other people got ideas on things. It wasn't all - Especially the test ops team that was part of this team. You know, get their ideas and be thinking about it the next hour or 2, get their ideas on - take the floor.

BUSH

Has any of the crew thought about the means of maybe an additional test with current configuration of experiments and data systems that we may have before we go into up-graded program for the next test. Either as a little test or of certain areas?

MUSGRAVE

I haven't, but I will.

SAWIN

Bill, it's been my thought before we ever went into this test, that now that we finally got this fine facility put together, it's a real shame that the day after we walk out of there people are going to start ripping it apart. And that one should consider mini sims or whatever you want to call them in specific areas. As Story said, I don't think we walked out of there with a feeling that there were that many problems that we need to work. That doesn't mean that other people on the outside might not want to get back in and have us do some things, or other people do. Like the WCS.

BUSH

. . . what about your subsystems . . . ?

MUSGRAVE

We'll think of things and most of the PIs are here and we'll get to them tomorrow. I know they're going to want their payloads back real soon. But what I've been hearing the management council coming down here in the next 3 weeks and a lot of other people want to get in and look at the facilities, especially with the visibility we've gotten. I think it's extremely important to keep that thing together long enough for these people to get a look at it.

HUFFSTETLER I'd like to ask the same question of Lou Would it benefit the test team . . . to continue the operation in the present facility?

DELUCA Which operation are you talking about?

HUFFSTETLER Keeping it up the way it is now.

DELUCA Yes, I guess I for one right now would like to go in and ask all the PE's to measure the actual power drains for what they've had so we get some kind of a number. We'll take those drains and work them against the time line that we flew with and see what it represents in terms of a peak power loading at any one time in the worst case. The categories I see are: sleeping power levels, experiment power levels, averages, experiment level peak powers, total power used - to let the Orbiter know - Well, let's first find out what that number says with respect to the baseline. And that includes X-21; I think we'll take the whole payload and add it all together.

CLARK Our power requirements all went in to somebody over in building 30, who did a complete study of what our power drainages were and things like that.

DELUCA I'm aware of that.

SPEAKER I don't know, was that done on Spacelab systems also?

DELUCA It's going in there. I don't know how much of it is there, right now. The point is, right now when I tried to look up the data we got spec data, not actual measured data. And I detect, in looking at what we saw out of the chart recorder, there's a big, big difference.

MUSGRAVE Which direction? More?

DELUCA A lot more was specified than actually used. There were times when you were coming up and if I would go through the ICD and list out all the power that was specified, the peaks should have been a lot higher. I suspect what we have is a list of maximum levels rather than the actual ones and I would just like - and that's necessary too, but it's good to have both.

CLARK One thing, on the sound level measurements that were made before things were modified too much, you see - The carpet should be pulled out of the middeck and redo the sound

level measurements with the carpet out of there. Because I think, from the dry runs that we had, when the carpet went in it did buffer the sound quite a bit from the BMS and from the oven. So another set of readings with that out of there should be appropriate, I think.

SPEAKER Is there any current plan for holding it intact . . . ?

HUFFSTETLER . . . another 3 weeks . . .

MUSGRAVE I need it just to come up for the final report. I need to get in there and get in front of each experiment and look at the thing and think about the history of what happened. I need that piece of hardware in front of me to go over what happened and pull out the lessons learned.

DELUCA Something I would like a bit of information too is that we lifted off in some power configuration and that's unknown. So between you and the PE I'd like to go through and find out what was on prior to the Spacelab entry.

MUSGRAVE I can tell you.

DELUCA Do you want to do that now or make that part of the systems thing?

MUSGRAVE We'll wait. I can tell you . . . what was powered up.

MILLER Story, in the write-up of your report, do you plan on putting down any amount of detail on the malfunction procedure . . . ?

MUSGRAVE No. What I do is - Well, in the first report, I put down the event that happened, then I put down what I think the meaning of it is and come out with a recommendation, what the lesson learned was and the recommendation. And in that I cite examples. I don't go down through each one and address every malfunction, but where I think there's a lesson to be learned from it, I state what the lesson is and then in parentheses I put down the examples that fit this lesson. There were very, very few this time, very, very few. As you know, we anticipated many, many more. They just weren't there. But I think a place to find those is probably the PI's report. I think that the PI's report, when they address their own experiment. I think if a malfunction occurred I would expect to find it there.

MILLER

What I was thinking about is, I realize - I think we discussed this with the PRR. There's not going to be a lot of malfunction procedures onboard, yet there may very well be a lot of malfunctions that have to be taken care of. And what level of detail the crew gets into relative to the systems, the detailed systems I think is yet to be defined. What I'm concerned about is that the crewman is going to do everything he can do to make this system work if it fails. But he also needs to know enough where, when he works with something, he knows exactly what he's working with in terms of say for electrical shock.

MUSGRAVE

I had the power off.

MILLER

But there's a lot of times that you could look at something, go ahead and fix it. It looks very innocent, but you may very well be working right next to something that could really zap you, if you don't have that type of detail aboard.

MUSGRAVE

I don't think it should be onboard. The way the training sequence is going, I recommended for the first one and I think about the same now (for the most part the ground's got responsibilities for malfs), that we should have enough training to become extensions of the ground. That we should be able to pull out a component and we should go to a certain valve and tell the ground this valve is in that position. We should be able to take a multimeter and go to a certain terminal on a certain bus that the ground has asked us to find and tell them what the voltage is on that terminal. In other words, I think for most of this stuff, the ground will become prime for most of the malfs and we'll become extensions of the ground.

MILLER

Turning the power off, of course, is one solution. I visualize we're going to be flying hardware that's going to have some superhigh capacitors on that thing. And we need to know the details of bleed down circuits, and when that capacitor's still hot, and this type of thing.

MUSGRAVE

But the number of malfs that can happen in this type of equipment are infinite. It's like trying to play a chess game with a computer; the alternatives are about infinite. Now if you've got a malf that we - we had some identified here, we did some malf training and we had some identified. If you've got a malf that's likely and recognizable, then you need a real procedure for it that you can whip out and do it. But for this type of equipment the numbers of possibilities are about infinite.

MILLER You would visualize, still, coming to the ground and saying, "this is what the problem is"? And have the ground team do their thing like they've always done in the past

MUSGRAVE Yes, but we should know enough about it to be good extensions of the ground. Accessibility, visibility, and be able to be extensions and tell them what's going on.

DELUCA As part of what you're talking about, you know, quite often this morning we mentioned that user's guide. Some way we have to provide the PI's away from us some insight . . . come onboard and all the steps that we go through. And again, of inviting their participation in certain things. Part of that should be to have them tell us of potential hazards that we ought to identify; the kind of things we would like them to tell us, so that should be part of the user's guide that says equipments of certain nature, you expect of certain things to be in it. And we'd like them to come back because, you know, in terms of the hazardous materials too, they're going to have to confirm that they do not have these kind of things onboard.

MILLER That will take place.

DELUCA And this part of the safety thing should be on that same nature.

MILLER We'll have some form of hazard analysis on each payload that flies. It's not going to be the depth of hazard analysis that we're used to seeing. But there will be a form of hazard analysis on every payload. And we hope that we can identify some of those type of things in the hazard analysis that will be of assistance in troubleshooting and malfunction procedures. That's the way we get a handle on that.

MUSGRAVE You have to impart even the philosophy to them about fixing something when it's remote. When they have something break, they call in the service rep or the technician, you know, and he comes in and fixes it and that's it. I don't think most people that aren't within the space organization understand fixing something when it's remote and you have a nonexpert that's out there with it. Yet it can be accomplished.

CLARK

. . . something else on a different subject? On the operations of the comm loop and the discussions that took place previously about the Science Manager and how the comm was handled. There were actually two modes of operations going on during this simulation. The science CAPCOM mode of operation for the medical experiments, which was necessary because of the level of the integration of all those experiments, and then a separate type of comm that was done on our type of payload where we had a ground support team that was there in the science support room. We also had a remote science area. So it was two totally different types of communications operations between the medical experiments and between our experiments.

MUSGRAVE

We had direct to the PI, too.

CLARK

Yes, but I'd like Carter to comment on the operation of the comm loop a little bit and how that worked out. I thought it went real well. Especially on our experiment where we had the remote science area support.

ALEXANDER

I think it went outstanding with the equipment that we had available to us. We understand that this is going to go away, but one thing that bit us the most in respect is the fact that you guys had some real-time demands at the same time we did and the way it was configured in the backroom where we were we had to relinquish air-to-ground to X-21 or they would have to relinquish it to us. It just depended on who needed it the worst at the time.

MUSGRAVE

Well, you know, we were talking simultaneous sometimes with both voices, but we still pulled it off. You know, you can filter your ear -

SAWIN

Plus we're going in between the handy talkie.

ALEXANDER

We could go with air-to-ground 1 and air-to-ground 2, perhaps, next time, if that would give us baseline for Shuttle

MUSGRAVE

If Orbiter doesn't require it, you've got another channel there. We're going to be running two channels simultaneously. And so, you could lash up the Orbiter loop like that if everything's really quiet on the Orbiter side.

DELUCA

In a case where it became necessary, then you could turn it over like this. The other other question that's starting to arise now is: will we have two loops as often as we think we will?

LAFFERTY

One further comment on an aspect of communication that we thought about but couldn't implement this time. That was patching an outside phone call from a PI into the air-to-ground. Carter was speaking of balancing act that we were doing there in the backroom. Well, I was doing that with an outside phone stuck in my third ear, for one troubleshooting episode we had there and if indeed we ever could implement this outside PI phone call patch in the air-to-ground, I think we could simplify some of this troubleshooting.

MUSGRAVE

That'll be there, but this sim surfaced that problem.

CRESS

It would have helped us on the WCS also.

CLARK

We needed all the help we could get on that.

MORRISON

One comment. It seemed to be the key - the same thing we heard on sim I - the onboard team effort of cross-integrating what you're doing to get the job done is the way to go. It really works. It doesn't matter if you're talking to two different guys at the same time the comm, or helping on malfs, or whatever. But I think one comment that needs to be pointed out here is that we've got an ideal case. Story Musgrave is a fantastic sparkplug, and I think that - take it through a different spectrum. I'm the kind of guy that works several different things at the same time, on a crash schedule. And you heard Chuck say he doesn't normally work that way, and yet you get swept up into it. And if you don't have a guy like Story that's in there as a sparkplug, it may work a little different if you get a PI from outside who's really a very narrow spectral guy. If you've got a guy like him, if you've got a sparkplug you get caught up in his enthusiasm, pretty soon you're working fantastic schedules and you integrate and you get the job done, as a team no matter what problems come up. I think that's an unusual capability we have right now. I wonder what's going to happen with . . . ?

CRESS

I'd like to follow up on that. Someone on the ground mentioned to me and I thought he paid you one of the highest compliments, at least I looked at it that way. We were just getting tired watching you in the air. He said he would rather go to Marine boot camp than be locked up for 7 days in there with you.

SAWIN It helps, he's a little bit crazy.

MUSGRAVE But to tell you, there were days - and I almost felt undisciplined doing it. But day 6 was a good one. But there were others that we were laughing and playing in a relaxed atmosphere and grinding out the work. There was a sense of humor there and it wasn't a malignant kind of aggressiveness where you're just charging. It was really a relaxed atmosphere and everybody having a good time and still really grinding out the work, I mean it was perfect.

MERRITT Story, there was one other aspect that was added that wasn't there on the previous sims. That was the aspect of the sim people being involved in introducing problems . . .

SAWIN It was just dreadful. Everytime Benson opened the door, I knew it was trouble. No, really it was a super idea. I guess it's not a new idea but I think it had some very beneficial aspects. Of course, you never knew how it was going to impact you, or whether it was impacting the ground and it made it real interesting. I'd like to have seen more technical, - I mean hard, like disconnecting a wire here or there - type failures, which really SIMSUP needed to come in in the night and do something. I guess it's a hard thing to incorporate, but where you really have a discrete malf that everybody's got to tear into. But, yes, we really needed it this time. We didn't think we were going to need it from experience last time but it just didn't work out that way. But we did knock them down in a hurry and there were some pretty grim alternatives. But there's only one way to play the game and it's a game, but then all the space flights and all this training and simulation we do to do it right the first time, it's playing the game as serious as you can. When you introduce a problem, we accepted it as a problem and carried the ball.

HUFFSTETLER That's the way, the reason, we were saying that when Bob Clark stuck his hand in the WCS we were afraid to tell him it was only a sim problem.

MUSGRAVE Yeah, that was (laughter) . . . grim.

SAWIN Wait 'til you see the pictures.

CLARK Yes, wait 'til you see the pictures.

SAWIN We closed that area off at least three times and said no more. Bob kept going back. He came out Sunday morning, he said, that is absolutely the last time.

MUSGRAVE We all had personal minimums..

HUFFSTETLER Bob gets the Roto-Rooter award.

MUSGRAVE It's a good concept. It failed but the waste management system is a really good concept. But it also points out how disastrous - I mean it's fun to joke about, but you get on a 30-day Shuttle mission and that thing dies, that is a disaster. It really is a disaster. Yes, it was seven crewmen, 30 days.

HUFFSTETLER We were remiss there in not having backup bags.

SPEAKER Yes, we had wet trash bags.

MUSGRAVE It didn't cost anybody anything. We had a trash bag that when it's 90 percent full you used it for that. It worked out fine; it was really easy.

#

SYSTEMS DEBRIEFING

ALEXANDER All right.

SAWIN What's wrong, Story, you've got the mike.

MUSGRAVE Glenn, what's a good order to - What do you think is a good order to tackle things here?'

CRESS What about the --

MUSGRAVE OTR's is one, facilities, . . .

CRESS Yes, OTR's and facilities, I suppose.

MUSGRAVE Operations, payloads or experiments.

CRESS Experiments are tomorrow.

MUSGRAVE Yes, but leave some of them. They kind of drive everything else. It's that kind of operations. And habitability; that's not covered by OTR's.

CRESS We do have an OTR on habitability. Yes, there's one under six.

MUSGRAVE Okay, should we start with OTR's? Or do you all want to start with facilities?

CRESS Here's an agenda already Vehicle Systems Reviewed, Habitability and Housekeeping, the AFD Operations, OTR Review, PR Status.

MUSGRAVE What's the first one then?

CRESS Vehicle systems review.

MUSGRAVE What's that?

CRESS The only systems we had are the facilities, I guess.

MUSGRAVE Okay, let's jump in.

SPEAKER Why don't we just address habitability and I think all that will fall out.

MUSGRAVE You guys want to lead that off?

CLARK You go ahead.

MUSGRAVE Okay. Food; Where's Rita? Is Rita here?

MUSGRAVE The food system was absolutely outstanding. There isn't anything you can say that isn't good about the food. The food was good, but the human factors and the layout, the stowage, the prep, the training, it was all absolutely outstanding. We could eat much quicker time than you could eat on the ground. The stowage was really good. Each meal was one package. You could reach in and grab the whole package and put it out there. Dr. Clark laughing over here. You all saw one meal on TV; that's the way we did it for TV. I guess you saw a few others that were the real-world way, you know what I mean. But just tackling the food system, the human factors were absolutely outstanding. You had one bag that was for each meal. You could pull it right out, and there you had it. The menu cards for tabulating the deviations of the human factors were excellent. The Skylab rehydration system, even though it didn't have the labels of - these guys never figured out whether - what was, you know, fill or eject; but all you needed was a few runs on it and it was right there. You could - they, they really worked really well in terms of a quantitative amount of water in the things. So that whole system was really perfect. Of course, Rita has been doing it since Mercury on, so she does it right every time. So that whole system, the whole layout in the galley is right there. I think we can make some input stuff for the Shuttle on that. The oven is loud, and it is not that fast, and from my experience, I'd say that the microwave oven is the way to go, if we don't have EMI problems or some other Orbiter constraints. It sure looks like - what do you got? It looks like microwave is the way to go. I think it's much more efficient in terms, that - you guys know more about that than I do, in terms of heat and the rest of the stuff. The oven did take some time. There was time - there were some times you were waiting for the things you heated up to heat up in the oven. You got any more on food?

HUFFSTETLER Would you comment on how long it did take for meal preparation and . . . ?

MUSGRAVE These guys are laughing because I have very little to do with the meal preparation (laughter). You know, there again, it boils down to what we were saying this morning about division of labor. There were three guys going to get the job done the best way we knew how. And Bob had - his payload was running most of the time. It turned out he had, most of the time, more spare time than we did, running things back there. If you want to do it right like - How long did it take you to set up that - the course you were - -

CLARK If you didn't have to use the oven - if you had a meal where you weren't using the oven, you could set up and do all your rehydration and have it on the table in 5 minutes about. The one comment on most of the food packs that we had: There was the plastic you had to cut off of the fitting that goes into the rehydration system. And those were that loose plastic on most of them. Now some of the ones we had the little cap, and the cap was much faster than cutting it off, cutting the other type off with scissors. But when you had three of them there, you lay out three trays and you start going down and snipping them all off, it just goes real fast, getting it ready.

MUSGRAVE Any time I got anything to say about food prep, these guys are going to laugh (laughter) but I -

SAWIN You cooked the dinner on TV, didn't you?

MUSGRAVE I could get a meal ready and eat it in 10 minutes. You got rehydration time, you save 3 to 5 minutes. But I don't wait for it to rehydrate. Put the water in and eat. You know, discoveries comes out kind of like crackers. But (laughter) it does all the same thing down here (laughter).

SAWIN No amenities.

MUSGRAVE There are times, John, to get the most done you really - the habitability stuff goes pretty primitive. You know, the heating and the rest of that stuff, you just do it as fast as you can, and quick, you know, and get on with getting them.

HUFFSTETLER When it didn't interfere with your duties, did your crew make an attempt to eat together?

MUSGRAVE We often ate together.

SAWIN We had breakfast, we had lunch whenever it was -

MUSGRAVE Whichever you called it. He would eat breakfast at his dinner time and that's probably what was confusing to him, two-shift operations. His dinner was really breakfast with us - I guess - is that right?

CLARK Something like that - -

MUSGRAVE But he would eat a breakfast meal at dinner time and I don't know what that did to his trying get his circadian shifts around.

CLARK I don't think that had much to do with it.

MUSGRAVE The general layout of the trays, the restraints and all that stuff -

CLARK Chuck did most of the meal cleanup.

SAWIN I'd like to sit down to a clean table. That particular situation was difficult. Story reminded me it would seem peculiar perhaps, but, it was very hard to find what to use to clean up after a meal. Even during a meal, you - it's just something like a napkin that you're used to using - a lot of people are (laughter) - Would be beneficial (laughter). In moving fluids or rehydrated things around, you'd spill a little something, you couldn't reach and wipe it up. It was a hassle, not an impossible problem but sometimes the place didn't look too shipshape.

MUSGRAVE Those guys didn't do it. I'd get out the silverware from the last meal say - and so and so tasted good as I cleaned the silverware off.

SAWIN Even he reached his limit. One day he put a wet wipe on his spoon and waited 20 minutes to dissolve the previous meal (laughter).

SAWIN It really wasn't, wasn't a big problem. The detergent that was put in there wasn't very strong, didn't cut through the things. There were stains on the table from

the drinks and things like this. I suppose if it was Formica and not a painted metal surface it might have not done that.

MUSGRAVE If I'm allowed to say anything about cleanup, the Velcro on the trays, you can't clean. It's - I suppose you have to have some form of restraint system, but trying to clean up the tray, it's the Velcro's the problem.

SAWIN Or out in the lab, I took a biocide wipe to that surface out there, after we had polished the rats off. It was, it stains, I'm sure everyone's aware of that because we used them previously, but you just accept that. It's going to be a slight brown coloration to whatever you use those wipes on. That's the iodine.

SPROSS Was there much conflict in using the table versus some of the other activity, maybe - maybe . . . place at the same time - was the table used for other than - the meal?

MUSGRAVE It sure was.

SAWIN Very useful.

MUSGRAVE We'd really have to have a table, not just for eating, but especially when we don't have a Spacelab and a workbench in the Spacelab, all the carryons and the rest of the experiments that are going to be stowed on the Orbiter; I think that's where they are going to be done.

SAWIN A place to set a flight plan down, a flashlight, whatever. A place to look at data. It was the only place we could all could sit together.

SPROSS Did you ever fold the table up or down?

MUSGRAVE No. No. Of course, we had excess storage room. We weren't, we didn't stow anything down below the table. If you did, you would do it. And also, if you had a inside airlock, which you might well have some of the time, not very often, you probably would have to fold the table out of the way to move back and forth.

SAWIN It could have been a - not quite so deep table and still could serve the same function. It was very ample in size.

MUSGRAVE I've got a -

SPROSS Size could have been reduced possibly.

SAWIN Uh huh. I think so.

MUSGRAVE I'd like to see it stay that same size when you start running experiments on that table. You can - you just know that every space flight program, you know who ever thought that there would be a rover on the lunar module? No one ever conceived of that. There's going to be all kinds of experiments stowed in the mid-deck that will be run right down there, carryon types and that sort of thing.

MUSGRAVE We just been covering the food system, Rita.

RAPP Have you completed it?

MUSGRAVE Well, we are kind of winding it up, and what I said was that it was absolutely perfect. The human factors were - the food was extremely good, the human factors were perfect. It was absolutely outstanding. The time it took was - you know, it was extremely efficient, it was absolutely perfectly laid out.

RAPP Was putting up meals on a split shift much of a problem?

MUSGRAVE No, but we cheated on it. When Bob was sleeping, we didn't go in and bang around and use the oven - you know - in the dark, it is hard to find things. We'd cheat and, before he went to bed, if we knew we were going to have to snack on some things or the coffee, we'd lay them out so we could get ahold of them without hunting and that kind of thing. In other words, we did perturb our eating schedule a little to try to - when he was sleeping, to keep him sleeping. Now when he woke up, we'd dive in there and hit the waste management system and the food and everything else, and then get out again. So, and vice-a-versa, he was extremely quiet when we were sleeping. So there's no doubt the two shift affected that kind of thing. But then we never ate when the flight plan said. We had lunch about 8 o'clock one night or 7, something like that. So we, - but you're able to vary that. But the whole setup, the human factor is absolutely perfect. The menu cards were logging the deviations; the pantry, the labels, you know, on the outside on the card and on the bags, was all just perfect. The only thing we thought was, and I know you are pursuing it, is maybe the microwave oven would be a good way to go. It would be a little

faster, and maybe a little more flexible, and certainly quieter.

RAPP Well, that's really not true. If you were preparing one meal, it would take say, 5 minutes. If you were preparing three meals, it would take 15 minutes.

MUSGRAVE The microwave?

SAWIN Yes, the more the mass, the longer the time.

RAPP And, it does put out heat.

MUSGRAVE It's not more efficient?

RAPP To do one baked potato, it takes 5 minutes, to do five, you know, it takes five times - 5. It's really not that efficient unless it's specifically designed to the food item.

MUSGRAVE The rehydration system worked perfect. It was just outstanding. The whole thing, it just couldn't have been better. Both the taste of the food and the ease of setting it up and all the human factors, perfect.

GEICK Those rehydration devices were originally, I think, intended to . . . mount vertical, and due to constraints were mounted horizontal . . .

MUSGRAVE No difference at all, upsidedown, vertical, sideways, and they're proven in zero-g. Rita, did the Skylab guys have anything to say about the rehydration devices that were on the table?

RAPP No, they worked.

MUSGRAVE Yes.

RAPP Did the Shuttle . . . food packages adapter work okay, on the square packages, and what was human factors like on that? The soup packages?

MUSGRAVE The same thing.

SAWIN Say, did you get to those . . .

MUSGRAVE You ate those.

SAWIN I ate those (laughter).

SAWIN They were good. The soups were very good.

RAPP Yes. They were hydrated . . . Once you cut the package open, you can eat with it. That's what I was really looking at.

SAWIN It's easier to get.

RAPP Easier than having to hold the bag open.

SPEAKER As long as you're willing to just trim the plastic away from the trays.

CLARK You notice we pretty well cleaned out the pantry. Didn't you? (Laughter)

MUSGRAVE The water was really hot. What kind of heater? Is that heater right at the outlet?

LINDSAY Yes. That's part of - That's the regular standard Skylab water heater.

MUSGRAVE That water was really hot. It was good. In the trainer, up there, we never really got hot water. You had to flush it a bunch of times.

RAPP But you can't really give me a good honest opinion of the flavor of the water?

MUSGRAVE I never drank a drop of water.

SAWIN Bob drank 4 ounces.

CLARK Yes.

MUSGRAVE I never tasted the water.

CLARK It was pretty flat.

MUSGRAVE We can go over it, I guess not if it's powered down. I never thought about checking the water.

CLARK It wasn't the best water as far as drinking was concerned.

SAWIN Living in Texas, how can you tell?

RAPP

MUSGRAVE

MUSGRAVE

RAPP

CLARK

CLARK

MUSGRAVE

CLARK

CLARK

MUSGRAVE

CLARK

CLARK

CLARK

RAPP It was deionized water with silver ions.

MUSGRAVE The way it mixed with all the drinks and the coffee and the food, it was really good. The coffee was outstanding, the drinks were. I can tell you it mixed very well with the food.

MUSGRAVE We got any more on the galley or food? We did say, Rita, it was hard to clean the Velcro on the trays when we get food on it.

RAPP That's was basically a one-g design rather than a plate. We hadn't used it inflight previously but I don't think we will.

CLARK Each meal we ate, the meal was unpacked. We took the bag that the meal was packed in and taped it to the front of the stowage lockers, and as we'd eat the food and put the tablet in it and stuffed it back in the bag and, when the meal was complete, we took the whole bag and put it down in the wet trash stowage area.

SPEAKER . . . 8 cubic feet trash stowage area. Was this adequate?

MUSGRAVE We used much more than that, though. Apparently the 6 feet was the top of the barrel. We filled the chute too. Wasn't that 8 feet in the barrel?

SPEAKER I believe so.

SPEAKER No. . . . 8-1/2 . . . 55-gallon drum . . .

MUSGRAVE That was the barrel? We filled the chute too, and I estimate that, on the final day, to get the lid closed, I was pushing about 50 to 60 pounds worth. I put my foot down in the hole.

SPROSS There're still some bags that weren't put in. They're still hanging on the walls.

SPEAKER You say you taped it to the locker? Was that something . . . provided with the food system, there?

CLARK Yes, there's a piece of gray tape on the bag with the label for the meal number and the day number, and just fold that back and tape it to the front of the locker and slip the used food containers in there.

MUSGRAVE There was a discussion preflight about what we ought to do with our waste food materials. And Rita thought we ought to exercise putting the biocide tablets in the wet packs and putting the food back in the empty lockers. Like if, you know, you got six meals in there - once you'd emptied out that locker that we put those empty bags with all the empty food bags back in there to see how that did. But the final word we got was to use the wet trash system for that. So I sometime along, if, if that's a feasible way to minimize the amount of wet trash we generate is to put the bags back in where they come out of once we free up a shelf, we should maybe exercise that on the next crew.

MUSGRAVE Have you done any tests that show that, you know, that that's acceptable?

RAPP That's the recommended procedure in Apollo.

MUSGRAVE And that worked. We probably won't have, especially on life sciences mission, greater needs for wet trash control. We may not have that much volume on Orbiter. The next time around, we ought to flag that as something to exercise, that yes, we can put the wet food trash with a biocide tablet back in the drawer from which it came.

SAUER What part of the trash came from the payload?

MUSGRAVE Plenty of the trash came from the payload.

SAUER Okay, were there any other procedures that are disinfectant procedures?

MUSGRAVE No, with the wet trash bags. There were two types of wet trash bags we evaluated: one Beta cloth, the other was a Beta cloth plastic liner inside it. We evaluated both of those. No, we just put it in the bags, pull the string on the bag, and down the hole.

SAUER Was there any kind of an odor from them?

MUSGRAVE Yes, when you lifted the lid, there was. Even though we turned the main vacuum valve to WTS to get some flow and turned the "collect" switch on, you get some flow back through. It wasn't bad. You opened the lid the odor was there; you close the lid and it's gone. But there was a lot of pretty rotten stuff going down the hole, you know, the dash sixes or the rats. The last couple of days,

feces was going down there. You guys can comment. I didn't think it was that bad.

SAWIN I agree with everything, except the speed which the odor disappeared. It took a little bit longer than - -

MUSGRAVE It certainly let up when you're just very fast on the door. (Laughter) And you get faster (laughter).

WHITE But you had an open ventilation system instead of a closed ECS system?

SPEAKER Yes, but I think we really need a wet trash system. And I don't know what the exact baseline volume for the Shuttle is. On the life sciences mission, you may want Spacelab to provide a wet trash system. At present, they only have bags - and they're Skylab bags. And the Spacelab bags, at present, got three little tips with holes on them that we used for Skylab to hang it in the trash locker. Basically, they are going with just bags.

SAUER . . . Did you compare them . . .

MUSGRAVE I didn't. I didn't think the liner was necessarily necessary. I found them the same.

SAUER We put that in there as an emergency in case the others did not work. Second, we also had the dry trash bag using a new type of holder. I know you're familiar with the Skylab one we had. How did this one compare with the Skylab holding system, and did you find the one that you can move from place to place more advantageous than the permanent located one?

MUSGRAVE Yes, the snap patterns didn't fit the bar. It was really hard shoving them on. Plus the snaps were - Did you find the same - did you move that thing around?

SAWIN If you'd just reach over and show something in the bag, invariably the bag would drop off the holder.

MUSGRAVE I mean the bags - the bar would fall off the snaps. The snaps weren't placed on solid structure. They were placed on light metal in between, so when you're shoving in, what you are shoving against is moving all over. And the snap patterns didn't fit that well. Sometimes you get only one snap, one snap. I think we ended up most of the time using them off the, off the snap patterns. It was pretty

hard to engage them on the holders. I thought that was pretty difficult.

SAUER Would you have preferred the Skylab pattern?

MUSGRAVE Yes, yes.

SPEAKER As far as the odors on WTS. Even a trash compactor today has an automatic deodorizer that spews out a little additive each time you open it. Something as simple as that might help to keep the cabin odors down.

SAUER Question that I thought of awhile ago - the trash bag holders was - they've had two types: One that was firmly attached to the wall and the other that snapped to the wall. You said the one that snapped to the wall does not work too well. How about the one that was permanently mounted to the wall?

SAWIN We had a discussion over that, as far as ease of access to it. Story made a good point. I was objecting to the fact that every time you wanted to throw something away, you had to essentially push your hand down into it, but his point was that in zero-g, you would want that opening to be closed so that stuff wouldn't start floating out on you.

SAUER That's why we made it that way.

SAWIN Now I understand.

CLARK The snap patterns and how well they held up varied considerably from location to location.

GAULDING They only had one that had a snap pattern.

SAWIN That was in the aft part of the spacecraft.

GAULDING The rest of them were all permanently mounted.

SAWIN That was the one that fell off all the time.

CLARK We had the ones that moved up there in the forward part. We didn't really use those up there. So there were snaps on the wall up front.

SAWIN Where you sat up there?

CLARK Yes.

SAUER Okay. Now as Story has already stated that comparing that particular closure system with the Skylab system that we had, the Skylab is the preferable system which if I remember right is the mousetrap type.

MUSGRAVE It was hard to put those bags on until you get one in there, and you really had to bend that piece of metal around to get them on. I don't know if zero-g you need something to hold the bottom of the bag. The bag might be floating, floating up like this. We had snaps on the bottom of the ones in Skylab.

JARBOE Awhile ago, you had a comment on cleanups. Now in general for housekeeping purposes, did you have sufficient wipes for cleanup? Were there sufficient cleanup provisions?

SAWIN Marginal, I'd say.

CLARK What we really could have used for cleaning up most of the things was just more washrags, more cloth rather than paper towels -

JARBOE Wet cloths were desirable?

MUSGRAVE Washcloths. Again, I'm embarrassed to speak about it, but a wet washcloth does a lot. Makes good recycling of personal hygiene things into the next dirtier task.

JARBOE Did you use your used T-shirts up for example for cleanup?

MUSGRAVE We used them for a lot of things (laughter). Yes.

SAWIN Are we talking about clothing or cleaning up towels?

MUSGRAVE Talking about clothing. Did we recycle underwear to - -

SAWIN I think we need something with some scouring capability. At home, you's grab an SOS pad, or some cleanser or something to really clean a mess up. Here all we had were some liquids. We had the soap out of the personal hygiene station, and we had this bottle of GSA cleaning fluid, whatever it was. Neither of those at all abrasive, obviously. You could use something a little stronger than that.

MUSGRAVE Like a brush.

SAWIN And we stowed things - animal waste, blood, things like that.

MUSGRAVE But the people that got into the spacecraft right after we went out, I'm sure saw the shape it was in. It was clean. I mean, we really handed back a good spacecraft. In fact, right now, it's the same as we - I don't think it has been cleaned up since we got out, has it? That's the way it is. We brought Dr. Kraft through it yesterday without cleaning it up. We really handed back a clean spacecraft. I think what we did worked.

SAWIN We used the vacuum cleaner. The screen size is so small that it clogs after you pick up a couple of items. You have to sit there, by hand, pick everything off the screen and throw it in the separate bag, then go back to vacuuming. That's kind of self-defeating except it does lift it off the floor for you. That's a real simple fix, I think. It has a large collection bag on it, but nothing ever reached it.

JARBOE The cleanup procedures, did this take long? Take much of your time?

MUSGRAVE (Laughter) Not much of mine.

SAWIN Not really (laughter).

MUSGRAVE You'd use cleanup the same as eating and food prep, and eating and cleanup, you'd use that as a time buffer. At times, things would get horrendously messy. I got some pictures of that table out there that, I mean, you know, you couldn't find your own silverware to eat with. It would be underneath the pile somewhere. And so that when you are really busy and you got things running out in the lab, you don't clean up. You let it get horrendously messy. You go do what you got to do back there; but then when you do get a spare time, then you tackle the cleanup. So we did not use in the flight plan, you got discrete places for housekeeping. We didn't use those times. We just kept running. Then when we got time, we got a break, then we'd tackle the cleanup.

SAWIN I think you could get along with two less utensils. I think just one large spoon and no knife. You don't need - at least, we didn't ever use a teaspoons, I don't think.

MUSGRAVE We pursued that in Skylab, and we had the foons and sporks and that kind of things. Those are combinations where you got spoons with little prongs on them. And we ended up going with the classical ones after evaluating some of them.

MICHEL In the zero-g condition, would you be able to let it get that messy?

MUSGRAVE Not that messy because the table was a one-g table without restraints. But my guess is that - you'd have to restrain everything - but my guess is you'd would use the same time buffer. You'd clean up when you got the time to clean up, but you wouldn't take discrete blocks of housekeeping time to do it.

JARBOE You wouldn't be able to let loose trash pile up.

MUSGRAVE That's right.

SAWIN The main thing, the key to that is just what Bob mentioned earlier and that is that each time you'd finish something - food pack, you'd take that and stuff it in that plastic bag that it came from originally rather than leave it where it was lying. If you kept doing that, there were never much accumulation. Just occasionally we got pushed for time and we'd leave the aftermath of a meal sitting on the table. Sort of grim to come back to.

MUSGRAVE Or you would eat half a meal, go back in the lab and work for a while and come back and finish it.

JARBOE Has anybody taken an inventory of how much - how many wet wipes, towels, trash bags you have left at the end - -

WESTOVER Yes, it looks like you used quite a few of the general-purpose wipes. It's just about empty. We've got five towels left over. All the washrags were used.

CLARK That may have been medically oriented toward my runny nose.

SAWIN The towels weren't very absorbent, they weren't very helpful. The washrags were very good, very adequate.

JARBOE On this type of material, the paper towels, etc. We also had pocket tissue packs on board. Did you find them useful, or would you rather not have them, just have more tissue and towel supplies?

SAWIN More of the standard size.

CLARK More of the standard.

JARBOE In other words, you didn't really use the pocket Kleenex type?

SAWIN Of course, I didn't need them.

CLARK That's another thing is that the containers that those tissues were in. There was more container than there were tissues.

MUSGRAVE Beta cloth containers. Of course, there's another thing, too. In terms of evaluation, each experiment had its own set of Kimwipes and tissues. And when you're out in the lab, I'd often use an experiment, like dash 11 had a box this high of these great big thick, you know, Kimwipes. Well, we were using those. They're there, we use them. The chromatograph had a box of tissues. Each experiment had a box of tissues in there, and they were being used. It's something else to consider in the evaluation. Probably they should - you know, the stowage list will - the stowage photographs will show those boxes.

WESTOVER Were the trash bag locations adequate?

SAWIN I would like to see one in the middle of the lab.

MUSGRAVE You need to be able to hang them anywhere. Probably something that would hang on a rail since we'll have rails along each double rack. As far as the Spacelab goes, something to hang a bag on a rail would be outstanding.

SAWIN To keep from leaving a mess, you would have to get up and leave your work station and walk to the aft end or something and stuff it in a bag.

MUSGRAVE Like you're putting electrodes on at the electrode drawer or something like that.

WHITE Story, what about the systems on this thing that the air conditioning on both the Orbiter and Spacelab - are they adequate or are there any problems with them?

MUSGRAVE

It's simulation peculiar, but we need to separate the rack cooling from the environmental cooling. In other words, we'd hate to have to live back in the Spacelab or some . . . We got to run colder because the electronics is not getting enough cooling. Now, in there we really had a discontinuity in the comfort curve inside this Spacelab because there was such a hur - we call it the hurricane because there was a very swift air flow when the fans were going. And most of the time, of course, we didn't have a top because we were always - we had about a 16 electrodes on all the time for one reason or other - and we were always plugging ourselves into something. So we weren't taking our clothes on and off and with bare skin, any kind of circulation really cooled you off. And even with the temperature of 80 in there, with the fans going, you were cold at temperature of 80. But when the fans go off at 80, you were really hot. So we were either hot or cold. As a matter of fact, every time we went to the 1300, we went to the thermostat, because it was hot or cold. There wasn't anything in between. You had to have a really hot temperature in there to be comfortable with those fans going. And yet we were always thinking about the electronics, and when something had started crump on PDP-8's on the 7, 8's, and 9, we were wondering, you know, what's happening, are they getting hot in there, because our own environmental system were tied to cooling all the racks. So, I think we need a separation in terms of comfort between the cooling of the electronics and the comfort index. You got something to say about the flight deck?

CLARK

Yes, of course, the aft flight deck. There's no ECS at all up there. The temperature is directly related to the temperature of the high bay. The first night was pretty cold, and - it was adjusted after that - but it was pretty cold up there that first night until it was adjusted.

MUSGRAVE

But a lot of this is sim-peculiar stuff that really isn't related to spacecraft ECS except maybe the Spacelab where we've got to take a look at how closely tied is crew comfort to rack cooling. Is it tied at all?

WHITE

How about the mid deck? That there was not a cooling system; it was just a fan to blow air in there.

MUSGRAVE

It worked pretty good in there, I - -

SAWIN The only problem there again, as Story pointed out, is sim peculiar. I would say, we talked about this earlier today briefly but, when you're in the rack, you can pull the curtains across you and you're sort of in a cocoon, without any air flow into that area. I would go to bed extremely comfortable, and it would be a really nice temperature and I would wake up warm, just because of my body heat and the fact I was isolated from the rest of the compartment - -

MUSGRAVE The Shuttle's got flow to each sleep compartment so that will probably be - that's probably fixed.

JARBOE Did you all by the way . . . time for any need from the earplugs or the sleep masks?

MUSGRAVE We tried them out; I think the earplugs are very helpful. I think I would wear earplugs. I resisted it the first few days. I just didn't like stuffing something in my ears, you know. Sleeping is kind of sanctuary, you like to go do your own thing. But Lou came out - where is Lou -

DELUCA Right here.

MUSGRAVE Lou came out and said have you tried the earplugs. I said not yet, but we will. So that night I - I used them all the time in general aviation flying for ear protection, but I just didn't think about that many hours. We went ahead and wore them and for myself, it really helped. It really helped.

JARBOE Do you use the plastic kind?

MUSGRAVE Yes, I can use the plastic type. I chose the cotton because for that long a haul; it's more comfortable; but yes I could use either. You'll probably find some resistance to it, but I think it's a good deal.

SAWIN The cotton is very adequate. Sometime on flying on the C-141's, we were given some wax plugs, which were very good too, and those weren't in the selection that we had. But the others weren't that comfortable, probably because they weren't a good fit. If they were individually fitted, I'm sure they would be fine.

MUSGRAVE Yes, I think we are going - I think those would be a real benefit.

JARBOE Okay, the eye shield, you did not use?

MUSGRAVE Yes, we evaluated the eye shield, and the ones that are real hard, they just don't work at all. They let light in and they're not that comfortable. The softer one, it's got a little bridge around the nose here. That seemed to fit a lot better and do the job. I didn't wear it all night - I didn't need it all night. We weren't going in there, we were cheating. Well, we were living, I mean, we were there for a week, so any cheating we did was fair, but, well, it's one thing, you know, to do it. If you do it for one 24-hour period, that's really cheating. This isn't cheating. We lived in there for a week. We did not go in. If we were scheduled for a meal and somebody was sleeping, we did not go in there and turn on the oven and bang and crash around and turn all the lights on. We did not go in and have a nominal meal. We kept the place dark. But I think, I think that is worth pursuing. I really think it's worth pursuing, depending upon what kind of curtains they came up with for the Orbiter.

JARBOE You turned out the mid-deck lights?

MUSGRAVE Yes. We left it dark in there.

WHITE Do you feel like there should be some sort of a night light provision in there, maybe?

MUSGRAVE Yes, minimal lighting, and I think the sleep compartment should seal out all the light. And the curtain, whatever you do to pull it around or sliding drawers, I guess, the sliding doors they've got, they should have some sound-proofing conditions too.

SAWIN It's one of these things - you don't really have to reinvent the wheel; on the ships, you know, they turn on red lights in the evening for, of course, for specific purposes, dark adaptation, but it would work here too. A dim red light of some kind, just so a person walking though the compartment could see where he was going.

CRESS Story, was the size of the sleep stations adequate?

MUSGRAVE It was, in my opinion, bigger than necessary; but as Bob Bond pointed out, you might want to dress in there too.

SAWIN Why?

MUSGRAVE For mixed crew type things.

SAWIN Oh.

JARBOE For SIM III, maybe.

MUSGRAVE For sleeping, for my purposes, they were bigger than they needed to be. They were taller and wider for that matter. I could have done with a lot less. Especially in zero-g when you're floating above it.

JARBOE You had a procedure for your clothing for overnight . . . stowage?

MUSGRAVE No.

SAWIN These were just tall enough, or there were enough clearance between the mattress and the next bunk bed that a couple of times - and only twice - I'm a slow learner, but I learned - I would pop up and I would crack my head on the one above me. And in peculiar, I just happened to catch one of the little support bars, structural bar, and it felt real good. So I guess I would ask that either those surfaces be padded or some accommodation made so a fellow didn't crack his head like that.

CLARK When you put the third bunk in there, we will be closer together and you won't have a tendency to do that.

MUSGRAVE If you had seven people in there, you might be doing experiments on there. I mean you can envision climbing in there with an experiment running in there because it's going to get crowded. Seven people airlocked inside, where are you going?

JARBOE You all had a sleep curtain . . . around that area. Was there any difference in the noise level with the curtain pulled versus closed?

MUSGRAVE Bob ran the study, but, subjectively, yes, big difference. What did you find?

CLARK I don't recall the exact reading on it. But we have readings - dB readings with the waste management system going, with the oven going, with both - taken from in the

bunks with the curtains opened and curtains closed. There was considerable difference in noise level.

CRESS On these split shifts operations, since you took turns using one of the bunks, were there any problems associated with that?

CLARK It was a game to see who made the bed.

SAWIN At that time of the day, you didn't really care. You just wanted to lie down, and it didn't matter.

CLARK But we did find that on the lighting that's in there, towards the aft end - and we did find that it was quieter and was more comfortable, for me anyway, to sleep with my head towards the forward end.

JARBOE It was a head bunk.

CLARK Head bunk. I think everybody ended up sleeping with their head toward forward end, didn't they?

SAWIN It's a little quieter because traffic up and down the ladder didn't bother you.

CLARK Well, there was traffic through there, and you did cut out a little bit of the sound by being up in the forward end where you're back behind the wall of the stowage lockers.

JARBOE You were operating experiments. You had, say, one guy down performing the experiments? You had a monitor. Did you rest in some of the chairs we put in there? And if so, what kind of restraints would you like to see maybe for the Shuttle Program at zero gravity? We put you some chairs in there. I don't know whether you used them or not.

SAWIN Which chairs? The blue chairs?

CRESS No, we had a . . . stool . . .

SAWIN Oh, in the lab itself?

CRESS Right. What I'm really saying is, as you are operating these things, one would monitor while the other guy might like on the ergometer or something. The guy monitoring, what did he normally do? Did he sit, or did he - -

MUSGRAVE No, he stood there, except for the microscope and the workbench. That's the only place we really needed a chair. And I've evaluated that the Spacelab by the foot restraint systems, that go up and down the handrails and the water tank and it looks really good. That's probably the way to go. If you are not doing it, by just floating in front of it or with one hand on it and the other hand running the controls. I think if you've got to station yourself somewhere, that foot restraint looks really well. You can slide up and down the rails, turn it upsidedown and also change the pivot angles. At present that looks pretty good.

JARBOE Story, we're onboard here, we had two different lab coats onboard that you could use. Did you use them? And if so, which one . . .

MUSGRAVE Didn't use them. Probably should have.

JARBOE All right would you recommend that for Shuttle, we provide lab coats, or that you increase the quantity of clothing, or what? Or would you need either?

MUSGRAVE Need more clothing. We only had one set of pants and one jacket, and as it was, we were putting these electrodes on and getting wired up continually, we didn't have the jacket on. But that set of pants really got dirty. I mean if you didn't tie it down at night, it would walk away. Between the blood and the urine and the waste management and the food and the rats, that just didn't go a week.

JARBOE Okay, you had one set and one pair of pants for one week - -

MUSGRAVE That's all we had - -

JARBOE And you recommend what?

SAWIN Well, at least three for a week, I'd think. It would be nice to have a change for every day - -

MUSGRAVE Three, three would be - for a life sciences mission, three.

JARBOE This comment comes from the three crewmembers, clothing, or the lack of . . . But the jacket, essentially, that is just warm attire or something . . . more particular?

MUSGRAVE Well, we rarely, rarely ever wore our jackets because of the instrumentation all the time.

JARBOE Okay, now - -

CLARK Not just that, I never wore mine either.

JARBOE If you'd had this number of pants onboard would you still apt to take an apron for your experiments or would you say that you never put it on?

MUSGRAVE My guess is I wouldn't bother to go get it.

SAWIN Maybe, it depend on what's your task is. Now I don't think our tasks required it, even though we did work on some rats. By the time Story actually got to sampling tissues, the animals were already dead, so it wasn't messy. But if you were trying to catheterize a dog or monkey or something, I could see where a lab coat would be very nice. It really depends on what you have to do.

MUSGRAVE Of course, the zero-g problem is probably you're less more likely to get into a spill.

JARBOE You could say then to put the need for lab coats on the . . . Primary experimenter to worry about whether it would be provided or not provided.

MUSGRAVE Yes.

WESTOVER One more question I want to ask you. Since you mentioned the need for a stronger cleaning agent, I wonder if you could identify the area where you might most need a stronger cleaning agent.

SAWIN Sure. The desk where we worked a lot, where we had biological samples, and the dining table, the food trays, the personal hygiene station, the WTS.

MUSGRAVE You're closed loop so you've got to consider the out-gassing of them.

JARBOE Story, back to clothing. During your sleep period, what did you do with your clothing?

MUSGRAVE Threw it over a chair, which would be analagous to clip-snapping it on the wall somewhere. Or clipping it to some clip on the wall somewhere, but slept in underwear.

JARBOE Also, on the subject of clothing, we had it stored in two different major configuration. Was one configuration better than the other?

MUSGRAVE I looked at both of them. Pull it out and grab what you need.

JARBOE There's no advantage of one tray arrangement to the other tray arrangement?

SAWIN That's a very small point, isn't it? It's not important.

MUSGRAVE I didn't use theirs. I had the flat one. Presumably they were dipping into my clothes.

JARBOE I'm not worried about segregation of the clothing problem. I know you wouldn't have that problem. But knowing that you could see what the other person was doing, what you yourself were doing, whether or not it would have been more desirable for you to have their system, or for them to have yours, if there's no difference. That's what we're looking for.

SAWIN Story's looked a little easier to recognize what you're looking for. But you don't have much trouble when you only have four items (laughter). It's not like walking in your closet and trying to select a shirt. It's pretty easy.

JARBOE What tools did you utilize, and can you think of any that you might recommend to be included?

SAWIN More versatile screwdrivers. Larger assortment of screwdrivers would be helpful.

CLARK They were all real long shaft.

SAWIN You know, we didn't - as Story said earlier today, we didn't have that many problems where we needed that much. We exercised the kit, but we sure needed -

MUSGRAVE We used a bunch of tools, though. We really used them. Toolkit is really essential.

SAWIN Nylon cord - -

JARBOE I was thinking of, you know, somebody is going to eventually pick this up. And, I'll have to put one together.

CRESS You may need a standard toolkit, and you also may need another toolkit that is unique to that particular payload that you're flying. The problem with this one, that - I don't think anyone went through all the various systems and looked at the size of the nuts and bolts and all the different tools that you might need in case you had a problem. Just a toolkit put onboard. It turned out that a few of them that we could use that weren't there.

SPEAKER . . .

CLARK Like having a -

SPEAKER . . .

CLARK Like proper wrenches we got into on repairs, on disconnecting the BMS. We didn't have a large enough wrench for - - the vise grip wasn't large enough to use.

MUSGRAVE We probably could use - we need a splinter group on tools, I think. We could spend an hour or 2 going over each task that was done. I think it is really critically important to have the right tools. We brought that thing out and, you know, we brought that out in the lab with us and we were really glad we had it. Of course, each experiment had it's own set of tools, too.

CLARK That was unstowed and taken out in the lab and left there because it was being used for something.

MUSGRAVE We were using it all the time.

CHASSAY I think whoever comes up with this - I have a basic list and I may be able to help . . . I'd like if we could get together . . .

MUSGRAVE We were dipping into - the experiment, you know, we got to know who had what. Same as the last sim. We knew what we needed, we'd go to that experiment and borrow his tools for a while.

SAWIN The best people to talk to on that, Charles, would be like the techs who helped assemble the gear, rather

than us. I worked with the gear but I didn't bolt it together and guys like John Donaldson or Shane Smith, people who actually had hands on putting the gear together might know a little better about what tools might be needed.

MUSGRAVE I think it's a really important, really important aspect area.

CHASSAY How about, we also put in miscellaneous supplies for stationery. Do you have some idea of what you feel like the experimenters or people should supply the astronauts. These are supplies. In other words is a clipboard with a pad more suitable than a little logbook for a pocket?

MUSGRAVE I just used a pen -

CHASSAY It's a personal preference type thing more than anything else.

SAWIN It's nice to have a grab bag like you had there to go in samples from, I even used paperclips. I didn't think I'd need them, but I got to sorting things out, just wanted some, and they were there, it was nice.

JOHNSON Story, can we talk about personal hygiene and the waste management compartment now. I have some more questions here. Since this is quite similar it turns out to the baseline of the Orbiter now, would you assess the adequacy of the volume of the head in relation to the size and adequacy of the layout?

SPEAKER Correct.

MUSGRAVE The waste management compartments?

JOHNSON The waste management compartment. The privacy aspects
...

MUSGRAVE The double door was really neat - to be able to fold the double door out - all the way out to the personal hygiene station and get that additional volume.

JOHNSON Did you fold it past where it mates with the galley? Is that sufficient volume.

MUSGRAVE Yes, that's beautiful volume. And just for using the waste management system, it's nice.

SAWIN

It's not a matter of modesty, because after you have lived together 2 or 3 days, it doesn't matter. It's courtesy more than anything, you know. If people are sitting there eating and someone needs to use the WCS, it's awful nice to be able to compartmentalize -

MUSGRAVE

But you got the mixed crew aspects, too. So you are going to have to provide privacy. And for privacy and taking a bath, quotes "bath," with the personal hygiene station, you need a double door that will swing all the way out to there. But you also got to consider the, the zero-g now. On that waste management system, the step was pretty insecure. You really didn't feel like you could stand on that thing. You know, you couldn't stand on it, because you can't stand on your heels very good, not and do the wiping not standing on your heels, and not be able to stand up, you know, it's pretty precarious. So most of the time, you - at least I would - I'd step off the thing and use the area out in front of it. Now in zero-g, it's probable you just hover right above the thing, do things there. This is the detailed debriefing we are doing now. We get into the details. But I think you'd have it - you really need a double door that would go all the way out there for taking a bath and all that business, especially for a mixed crew.

GOULDING

Did you use the little curtain flap up to the aft light?

SPROSS

I don't think they did because we covered over that other hatch.

MUSGRAVE

But, yes, I think you ought to have that, too. I think you ought to really be able to seal that area in for mixed crews. And for the other aspect, maybe light shielding - no - for sleeping or something - for mixed crews you probably ought to be able to seal off that whole area.

SPEAKER

. . .

MUSGRAVE

No. In zero-g, you don't know whether you're heads up or heads down.

SPEAKER

Seal that entire area if possible.

MUSGRAVE

I thing that's desirable.

JARBOE Okay, with the door closed; or did you use it with the door closed, the sink and the mirror was there sufficient room in there?

MUSGRAVE Yes. You can take a sponge bath there with the door closed. Standing up, of course. And you will have even more area when you get zero-g.

JARBOE Story, still on personal hygiene period. We provided you with three separate kits as we have in the past and we have the difference between three periods. We gave you different toothbrushes different toothpaste, and also gave you a different . . . your hairbrush or comb.

MUSGRAVE Yes, that's good. Outstanding hairbrush you had there.

CRESS . . . to the crew on the part of the . . . I would like to know did you find any major differences. In other words, did you find inadequacies in those items. Now you were using the regular . . . razor that you've used before.

SAWIN I used the Techmatic instead of that thing that was supplied, which I gave up 10 years ago, or whenever they went out of style. Someone had said don't use a Techmatic, because you can't cleanse it. Well, with that jet stream of water in the personal hygiene station, you can clean it very adequately. And even if you couldn't, you could throw one away everyday and not take up must more volume than with one of the old double blades.

JARBOE Did you use the shaving cream that was provided?

SAWIN That's fine. That worked well.

JARBOE Okay, can you tell me right off hand, was yours - the military or . . .

SAWIN I thought it was Gillette.

JARBOE Okay, Bob, you didn't know if it was . . .

CLARK I didn't shave that much, but when I did with that razor that was provided, I cut myself. I'd rather use the Trac II or something like that.

JARBOE And the shaving cream, were there any problems with that?

CLARK That was all right.

SAWIN The deodorant was very good, too. That stick deodorant, I'd never seen it before on the market and it was good.

MUSGRAVE It was Chuck. He brought me out my stick.

SAWIN Story said what's this? I said that's deodorant, Story, try it! And I said have we got that? He said I don't smell. I said you're . . .

MUSGRAVE This is really a detailed debriefing. It's not really applicable to the spacecraft environment is much drier. But I didn't really stink until day 5. . . . But I'll tell you, in 9C and really pouring the sweat out for an hour, it kind of cleaned up. That and the sponge bath, and I was back about to day 1.

SAWIN On the personal hygiene station, I would have definitely have gotten a shorter haircut if I were going to do this for real. It's impossible to wash your hair in there, I think. Virtually impossible.

MUSGRAVE Except for that example of rinsing that razor, we really weren't using the flow characteristics. It was better to wet a washcloth and scrub.

SAWIN I used it to wash some respiratory valves. It worked nicely for that.

JARBOE What was that again?

SAWIN It was a little valves we used for pulmonary function and cardiac output measurement. The force of water flow was very nice for washing that.

JARBOE How about the light in the Orbiter? In that particular range . . .

MUSGRAVE Good light everywhere. Was that fairly baseline? Was that something like the - good light, really good lighting. I'm amazed it was that much.

JARBOE Were these special lights on the table . . .?

MUSGRAVE There was a lot of light in there.

CRESS - too much?

MUSGRAVE No, you could turn them down. We need to control Spacelab lights, I know we got individual switches now.

DELUCA No dimmer control.

MUSGRAVE But something like echocardiography. You've got to get them all out.

CLARK And the same with the stereo.

SPEAKER . . .

WESTOVER What all did you . . . use the personal hygiene station for?

SAWIN I always used the wash and dry, or the wet and drier, alcohol wipes or utensils to clean up the trays. Primarily just washing hands, face, and body the best you could.

WESTOVER Did you stay within the compartment for sponge bathing?

SAWIN I never bothered to put the door up myself but you could, plenty of room. Since there were just three of us, it was no problem.

WESTOVER Was the water temperature good?

SAWIN Very nice.

JARBOE We touched earlier slightly on the wash problem of the towels available and that you would like to have more towels for cleansing the vehicle itself. Step 1, though, on personal hygiene, were they adequate? Did you have adequate quantities? Did they properly absorb water?

CLARK The towels didn't.

SAWIN Yes, the comment on the towels would hold for whatever use. They are good for hand towels, but if you're doing a total body wash, they are really not too adequate for that.

JARBOE So you would prefer a different kind?

CLARK A towel with some pile on it.

JARBOE A towel with what?

CLARK With pile on it.

JARBOE Okay, so you would prefer that type of towel?

WESTOVER Was the liquid soap adequate or would you rather have a bar soap?

SAWIN It was okay. Of course, we had some problems with it, I guess, were peculiar to the operation of the facility. That first day I came out and walked in there, and the soap was pouring down like a water fall. But it was good soap, it had a pleasant odor, it cleansed well and it didn't irritate.

WHITE Story, did you all ever use any of the overhead storage or the underfloor storage, that was never used was it?

MUSGRAVE In the Spacelab?

WHITE Right.

MUSGRAVE No. No. That would have been, in one-g, pretty grim. We opened them to see how they opened. The Spacelab lights have got to be able to be shut off. Stereometric photographs and echocardiography are two of them. In other words, you might design it so that - yes, you can get them all off, but a couple of emergency lights. If those can't be shut off, then we need covers to cover them.

CHASSAY How about the lighting in the work station, was that adequate there?

MUSGRAVE Yes, that was fine. Now I know Spacelabs, has got at the PRR the requirements were, I don't know how many thousand candle power. It's a huge sum the life scientists put into that. I think it is excessive. We'll take a look at that at the next Spacelab design review. That was adequate.

JARBOE The stowage on the forward bulkhead. Were there any type of traffic-pattern problems, access problems to those lockers?

CLARK Well, the clothing, for example, probably would have been more adequate over by the bunk, but all the food was right there where it needed to be. Other than that, I . . .

SAWIN Grouping of all linens in one area, if possible, might be more logical, but we had our personal clothes above the food, and we had towels over the other side. It's really not a big thing, but it might be more logical to put all things that are similar like that in one area. It might be easier to remember where to go.

JARBOE Do you normally take the little boxes out and lay them on the table, or do you just find them and pick what you want?

SAWIN Which ones?

JARBOE The stowage boxes.

CLARK Both.

MUSGRAVE Like the bags in the cleanup and all, we took that box and had it out in the Spacelab most of the time. You need a place to hook it down out there and something to keep the bags in it.

JARBOE In other words, you're saying, in orbit you would actually open up a locker, remove a tray, and take it to the use location?

MUSGRAVE Yes.

SAWIN Perhaps have a Velcro cover over the tray's contents.

JARBOE They definitely need to be removable from the stowage lockers.

CLARK I mentioned one thing on tiedowns for zero-g. Although it was sim peculiar, the carpet tile that was in there was excellent pile that worked well with Velcro. You had areas where you could take the carpet tile and put it on the front of the locker, for example, and you could take the - Velcro the food or whatever and just patch it right on to that. And you don't have to worry about hitting a pile of Velcro this big to another piece of Velcro this big, you could just slap it up there.

JARBOE Of course, that's a flammability problem that's why . . .

CLARK Yes, if there was such a thing, it could be where you could have a large area where you could fasten things to,

rather than little bitty pieces where you had to hit one on one.

WESTOVER Did you have any problems with the cloth drying restraints you push in?

CLARK Great -

SAWIN They're well tested. I've had them in the kitchen for about 8 years.

MUSGRAVE They were in Skylab, too.

WESTOVER Did you use two washrags, one for rinsing, and one for soap? Or did you just rinse every time?

CLARK We used two.

SAWIN Two the whole week (laughter).

WHITE Do any of you have any recommended modifications to the Orbiter and of the mockup?

SAWIN You mean as - -

WHITE As opposed to the Spacelab.

MUSGRAVE I think we addressed the problems of the two-shift operations and noise and light, sheltering for sleep.

SAWIN Stowage in those cabinets in the aft flight deck area. We had a Tandberg recorder stuffed down into one of those.

MUSGRAVE Are you talking about the flight deck?

WHITE Both the flight deck and the . . .

SAWIN The human factors on that one are not good, but I guess it got kind of late in the game and we got to put the recorder somewhere and that was where it went. It was really some of the goofs we had the first day out, caused by me in particular, related to the fact that I couldn't see the heads to thread the tape. I just kind of reached over and dragged the tape across and missed an idler pulley. When it came time to change tapes, it was difficult to get tapes on.

MUSGRAVE That's probably -

SPEAKER Is this the one in the aft flight deck?

SPEAKER This is a problem with the lights.

SAWIN Well, it's light, clearance, it's everything. When you're trying to get up over it, you can't, so you sneak around the sides. You just can't get in there to work.

MUSGRAVE The problem was fidelity during training. During training, the end wasn't sealed off. So that during training you pulled this lid out here and you worked with the tape like this. Well, you don't know that it's going to be sealed off here, and you're going to have to go over the top when you get to doing it for real, and that was the first time we did it. So the visibility - We'll have a problem in the real spacecraft - access that are put in those stations.

CLARK One thing that's needed up there, at the payload specialist station is, with all the stuff in the racks, there's no writing surface up there. If you want to write on anything, there's no writing surface whatsoever. Maybe a writing surface could be there that could be pulled out or something or other. As it was, you had to write on your knee or something or other. No flat surface available.

SPEAKER The baseline does have a portable working surface.

CLARK Okay, good.

SPEAKER Do you have some sketches or drawings on that?

MILLER Story, did any of you have any problems with that carpet on static electricity? Getting zapped with it?

MUSGRAVE When it first got laid down, there was some, but it went away.

CLARK It was mainly because we were in there in street shoes. When we put on sneakers, the problem went away.

MILLER In other words, it was the type of shoes you were wearing?

CLARK I think so.

MILLER I think that you ought to sell that carpet to Houston Light and Power.

MUSGRAVE In sneakers or bare feet, it was all right.

DELUCA . . . all of the crews from here on out will be wearing that type of shoes.

SPEAKER When you get - we're not going to have a carpet, I don't believe, in Spacelab.

JARBOE No, I'm talking about future tests over there in those facilities.

MUSGRAVE My guess is yes.

SPEAKER We'll provide the same shoes?

SAWIN Howard went to a lot of trouble to locate those.

SAWIN Really, a lot of effort went into the selecting those. They weren't just - they didn't go down to the dime store and buy them.

JARBOE Yes, I understand.

SAWIN They were fine.

JARBOE Story, we provided - for general utility use for three separate pairs of scissors, being somewhat different in design each of the three. Did any of you co-use those scissors. Did you end up throwing one or two pair away? Or did all three . . .?

SAWIN Get yourself a pair of Rita's type. In other words, we used the bandage scissors, I think, in preference to the straight blade ones, which didn't seem to work.

CLARK You had a pair of bandage scissors in there, but they were too large and cumbersome. The ones that were with the food prep kit were just the right size for all the tasks.

JARBOE Okay, so the ones that Rita had is what you would want to be provided for all uses? You've seen the ones we had on Skylab. They were considerably larger than these.

MUSGRAVE I like the long snouted straights fine too, so you got a difference of opinion.

JARBOE To the point that the others would not provide something that you could use, that the long straights would?

MUSGRAVE Not to that extent, no.

JARBOE The type that they're saying would be adequate for an all-purpose vehicle system?

MUSGRAVE They're mostly used for opening food. Slipping that little hook on the bandage scissors into the hole, then cutting along. It really slipped into that hole very nice.

JARBOE Say before we used to use those big ones we had onboard to cut anything, did you see any need for having those large scissors? Would there have been places you would have used the Apollo/Skylab scissors if you'd had them?

MUSGRAVE No.

JARBOE Okay, so - -

MUSGRAVE Not this trip.

JARBOE Just for general information, for the next test we make, it would be interesting to know could you actually hear what was going on outside the test? There were some louvers down on the end of the payload there - -

MUSGRAVE No. Very little.

JARBOE Very little?

CLARK There was other sensory perception that you could tell when - especially when the guys got down there to release the vacuum and change the cold trap out. The odors went wafting up to the aft flight deck.

MUSGRAVE But occasionally you would hear something.

CLARK I guess when you took the cold trap off. I was smelling it up there.

SPEAKER Yes, you sure could.

CRESS The sound wasn't objectionable then, in operating the experiments or anything?

SAWIN No, they heard us more than we heard them.

MUSGRAVE How much did you hear on the outside there?

SPEAKER It sounded one night like you were having a big party in there.

MUSGRAVE Was it coming out to the consoles?

CRESS I think we heard you more at night it was quieter outside. In the daytime, I think the ambient - - there was more noise outside in the daytime, I don't know if you all noticed that or not.

MUSGRAVE No, didn't bother at all.

SAWIN We were thinking it was sort of strange, Saturday, I guess it was, the doors were rattling.

SAWIN Yes, Story said, what's that? I didn't even hear it.

MUSGRAVE I'm on the vestibular chair. Man, I heard the doors really rattling.

SAWIN The doors were just shaking, like they were going to come off.

MUSGRAVE And I'm wondering how my airplane is doing out there.

MUSGRAVE They were really banging away, you know. That was really the only strong input that went in.

CRESS I can't believe you didn't hear the servicing of the cold traps.

MUSGRAVE Yes, we heard that. But you know it's like any other cycling spacecraft system. Really, we had a good sense of isolation in there.

CRESS Couldn't service it any other place, but when we shot that nitrogen to it, it made that spewing sound.

CLARK The first time I heard it, I thought it my magnet transition backed up.

MUSGRAVE We've finished up the habitability except for the WCS.

SPEAKER How was the comm inside there?

MUSGRAVE The comm?

SAWIN It depended on the ambient noise level. If you had a lot of ambient noise like with Story grinding out on the ergometer, you had to turn the volume up, if you didn't want to use the earplug, which I didn't. Then you had feedback problems. Other than that, it was very good.

CLARK The speaker box on the aft flight deck overhead, you couldn't crank the volume up loud enough to really hardly hear anything. You had to use a headset all the time.

SPEAKER Was that from the beginning or did that just . . . ?

CLARK That was from the beginning.

MUSGRAVE We need a speaker box back in the Spacelab, and we don't have it right now. And you just can't imagine some CDR/PLT going down there temporarily and having to plug into a headset. And also for the subject who wants to know how things are going, he is also concerned with how the data and how the experiment's going, and he wants to at least hear one end of it. So we need a speaker box down there in the Spacelab. And also the headset we had this time, you weren't able to go hot mike. There was no way to latch the thing. And there were a few times when that hurt you, like if you wanted to go over to the chromatograph or something, and be talking and pointing things out, say on the TV or, especially, say, microscopy. If you're having a running commentary with a PI who's looking at what you're pumping down through the microscope, you need two hands to run the microscope and talk. So you'd like a hot mike in that case. So the next time we ought to - We did the first sim. So next time we ought to have a switch that we can key hot mike and leave it on. Wireless comm would really enhance it. When we get into zero-g, and you know what umbilicals are like in zero-g, and we're dragging headset umbilicals. We got four people who are working back there and all the bio-instrumentation that's hanging around, it's really going to be a snake. I don't think we're going to win that, I don't think we ever will. But wireless comm - you know, we have it everywhere else, and that's something we really ought to work towards. I don't think we'll win it.

CRESS There's a proposal - -

WEGEMAN I have one more question, especially for Bob. During the night, there was a lot of times was monitoring the air-to-ground transmissions which we recorded all the time, and I was getting one-sided conversations. I was not getting science room. I could hear you talking or I could hear science room way down in the mud, in the background.

CLARK I was always able to hear them adequately with the headset.

SAWIN I was going to say that it might be that they just got tired of listening to you, Bob. . . . powered down.

CLARK No, I noticed no problem with any of the locations that had talking in the background.

MUSGRAVE Of course, we would like a - if possible, on the next one, we'd like an intercom. We had the walkie-talkies, but you don't carry those around on you. You put them down somewhere. I guess, we asked you guys after a couple of days did you mind our using - I guess after the 2 days of integrated sims - if you minded our using the air-to-ground as an intercom, and I guess it didn't bother you all what we did. Mostly we were using it just for switching the TV monitors.

CRESS It really helped us knowing more what was going on.

SAWIN Yes, the rf's with the handy talkies tore up a couple of our more sensitive experiments.

MUSGRAVE That's another - the rf from the walkie-talkies, you could see it in the vestibular particularly.

SAWIN He was doing the ocular nystagmus and I would click the thing off. It took me twice to realize what was happening. It just banged off baseline.

MUSGRAVE It's amazing how I have never seen a vehicle so free of emi. And the walkie-talkies, yes, but they were add-on. The thing was absolutely clean. You'd crank up one experiment, and on another one, you wouldn't see any effects. It was really clean.

SAWIN We had one or two times where, when we initially started taking VCG, we had noise on the signal. And before we were able to define the source of it, it went away. And both times the signals were superclean.

MUSGRAVE Some of the time it was not on the bike but just doing a cardiovascular series. We'd come with noise on it, and it went away. Don't know where it came from. And it wasn't that we didn't have the electrodes on for hours. Don't know what did it, but it was very clean, in terms of emi.

DEAN We had the filters in the light system. Also each of the 28-volt 400 cycles, and 60 cycle had its own oversized ground line. That may have had something to do with it.

MUSGRAVE It was clean, really clean.

BOOHER The echo system was completely isolated. It had its own isolated transformer. The only thing we ever saw was that crazy 2- to 3-kilohertz, kept coming through on the EMG. We're going to see if we can find that over there now. It never did get to where we - we always got data. Every once in a while, it was more noticeable than at other times. I think it had to do with the time of day. We could correlate either what was going on in the lab, or perhaps what was going on in the building. But other than that, it was absolutely unbelievable.

SAWIN The facility was super. We had no power outages, we had no loss of vacuum, we had nothing. It was really good.

WHITE Story, with all of the - this may be a little bit different type of question - with all of the shelf-type gear, did anybody ever bump into switches and knock them in the wrong position - back in the lab?

SAWIN I don't know.

MUSGRAVE Did you ever inadvertently, passing by, hit something? We were really concerned about running around the end of the stretcher to go and hit the FR-1300 everytime. The PDP-8's were sitting there on that end of it. We knocked - out of a similar experiment we knocked the take-up reel off of that. But we knocked it off dragging the skeletal - muscle chair by it. You hit with your knee once. So, that was sticking out pretty far from the general layout; we hit that twice. But in terms of inadvertent switches, I don't think there was one.

NOLTE Okay, how about the tape recorder on the aft flight deck? It was found in rewind pretty early, could that have been knocked?

MUSGRAVE Yes, remember that thing went to rapid rewind, did you ever find out why?

SAWIN That was day 1, right?

MUSGRAVE No, it was later than day 1.

SAWIN Was it later than that?

MUSGRAVE No, it was day 1.

SAWIN It was day 1 because that was me again, and I don't know, probably me and not Ed. I don't think it ever happened to Bob after that.

MUSGRAVE It doesn't sound like an inadvertent.

ALEXANDER What about the density control on the hardcopy device over with 7, 8, and 9?

MUSGRAVE That was very fine, that's fine. One click over and there's nothing.

CLARK It's sensitive to about - a 10-degree turn on that thing is enough to throw it off.

ALEXANDER Do you think you hit it inadvertently when you had that problem?

SAWIN Oh, that time that it went down. I don't know. I'd question that because at near the end of the mission, I think it was a sick piece of equipment. Near the end of the mission, we started getting just hellacious contrasts on those copies; they were coming out almost dark.

ALEXANDER Yes, I saw those Sunday afternoon.

SAWIN And there's supposed to be, I understand, a refrigeration unit as part of that and I'm wondering if it's holding up or not. That keeps the paper fresh. And if you don't refrigerate the paper, like we keep all spare rolls in the refrigerator, then they tend to develop. And I wonder if there might be a malfunction in the unit. I just don't see how I could have reached over and turned; that's a rotary switch. You'd have to actually grab a knurled knob and turn it.

ALEXANDER Pretty good friction on the switch.

SAWIN Yes, it's just not something you'd inadvertently do.

ALEXANDER It's not likely that you would have hit it. . . . sure it corrected the problem.

SAWIN Bob got on that and rebalanced the CRT output and the contrast on the hardcopy unit and it worked fine again for the next 3 or 4 days.

MUSGRAVE It raises a good question about what kind of shields the Spacelab ought to provide or payload ought to provide. I often looked at the PDP-8's on the dash 11 and wish they were recessed a little bit. Because if you ever got to that switch register or something and didn't know, it would really slow you down for a while.

CLARK Yes, there's a lock capability on that switch register.

MUSGRAVE Yes, we left that in lock all the time on those. But we did rely tremendously upon going back to something and having everything where it was. And in the first sim, we had a couple of them - the dog one came up completely out of configuration. The vestibular one this time they had been working - the problem we had with I guess the ECG appearing on the vestibular one and they - Out of their own testing they have been getting out of configuration - And when Chuck was powering that one up, it cost him a bunch of extra time to really verify that everything was really there. And I think the first time we go to run on that, we're going to have to verify the positions of everything. But if you look at the total number of controls we had, we were relying very heavily on not using a checklist and on having it right there where we left it.

WHITE The sim guys were bugging me for some problems, and that's one I thought of too late to give to them to let them come in and bump some switches for you.

MUSGRAVE Boy, that would have set us up. I mean, we would have been dead in the water. Because if you look at the length of checklist it takes to verify everything in the right place that we depended on as being where we left it. And that would have - we would have really be hunting.

DELUCA We brought something up a couple of minutes ago. Given the case where a recorder is used onboard to bring back data tapes such as the 1300. Given that case, it seems

as though there ought to be a multiple set of panels to initiate the recording at the racks where you have the data generated, instead of going back to the recorder each time.

MUSGRAVE

This is like CDMS.

DELUCA

I'm just saying - I'm reading that outside of the CDMS, to bring back - the CDMS is to format the telemetry to bring back, it's not for data recording. But if there's ever a case that comes up where you want tapes back - Now that might be test unique, but on the other hand going back and forth sounds like a nuisance every time.

MUSGRAVE

The CDMS will not store data for final data return?

DELUCA

Well, let's say right now a - To the best of my knowledge
- -

MUSGRAVE

Do you provide data storage for payloads in the Spacelab?

DELUCA

I don't think that does that. I don't know what our final capabilities is going to end up, but the point is that's for generating the data - due to telemetry formatting and forward it to the Orbiter, in the terms of the data per se.

SAWIN

It would be a convenience. I would say also though that we were just going by the procedures we had agreed upon before we started the test itself. By that I mean, in running the cardiovascular series for instance, we would shut off the tape recorder between the specific tests, even though it might be for only like 5 minutes. And we had plenty of tape, we could have just as well let it run for the morning and done the whole cardiovascular series.

DELUCA

But the question I have is - is, you know, was that just for this test, because of the data system we have? If you get all of that on telemetry, then would there still be a need for wanting to get the raw data right off of the tape?

MUSGRAVE

You mean a playback - an onboard playback system?

DELUCA

Well, we got that, there's that capability. No, I'm talking about - No, we want the raw data, as it's generated for some reason.

SAWIN

Some people will want that.

MUSGRAVE

CLARK

On our particular experiment, we need to have it recorded onboard because there's 100 engineering values, there's 44 words of information that come down for each event and 1-1/2 events per second, you just don't have the capability on the ground of looking at all of that in a given time. So you might have a problem in the downlink that you might not see for a while. So we would want raw data recorded onboard, but in our function, it would be on the orb - through the Orbiter systems recording. We do have that requirement.

DELUCA

The Orbiter does have a recording and a dump capability, which means that you can get all you want. It's a question of whether or not you're off-line for some reason when something happens.

CLARK

MUSGRAVE

Okay, shall we finish up the WCS and then we're done with habitability.

MUSGRAVE

WESTOVER

What about that five-way valve, was that any problem operating that?

SAWIN

SAWIN

Kind of a nuisance, Brock, in the sense that, supposing one person would like to be using the personal hygiene station and another person is stuffing something down the WTS [sic], it would be nice if they had independent vacuums. That would just be a convenience. Another thing I think vacuum would be nice for is small animal housing out in Spacelab. You could pull that through your same filtration system. Those rats got really rank, and it - you know, we were counting the days until we could put them away. Even though we changed the litter - And we had only 12 animals. Well, I could conceive of where you might have 100 animals or 200 animals on a flight.

MUSGRAVE

MUSGRAVE

Well, I think that's simply cured, we have identified the need, as part of core equipment, to provide an onboard vivarium, independent ECS-type thing for small animals. I think that was sim peculiar. We were assuming we had an, you know, animal ECS system.

CRESS

SAWIN

On like day 3, riding in the vestibular chair, you knew where you were each time around. It was really that way.

MUSGRAVE

MUSGRAVE

Is Dick Sauer here? Is he coming back? Do you know? Well, I guess we'll wait for the detailed discussion until we see him. Conceptually, I think it's a WCS and a BMS is a neat system. I think you can use it very easy. You can take a sample very nicely. The concept - I don't think there's any way they can build a 2-millimeter probe that's going to go through something, and even though you to let out real slowly - to penetrate a septum, you're going to have a leak. I don't think you can build any system that you're going to penetrate with a 2-millimeter probe that it isn't going to leak a little. And they got the light sources right underneath that, right next to that septum. And light - Any kind of liquid on that knocks them off. I think they've got to separate those.

CLARK

They told me they are working on a magnetic pickup on that as opposed to a light sensor.

MUSGRAVE

Yes, a magnetic pickup instead of light, and that won't be liquid dependent or something else. Conceptually, it's really a neat system. No problem at all with doing that. So is the WCS.

SAWIN

I'm sorry, we're talking about the sample tubes on the BMS.

MUSGRAVE

Talking about - magnetic sensors, yes. Conceptually, it's a neat system and we sure need to pursue it, and get the reliability up, and take a close look at the logic. And I think that's something we ought to have training in the logic on. We had absolutely - We had the briefing on the system, on the operation, we were all set to operate it. But I think on something like that we ought to have a flow diagram that we can know what the logic is and how to bypass it or how to fix it or how to diagnose where you are. And we didn't really get a flow diagram on that before. That's something you ought to know the system pretty good.

CRESS

. . . If you look back before the test, that was the one system that everyone seemed to have a very high degree of confidence in. You knew it was not going to fail, and we were concerned about the experiments, which were still operational.

MUSGRAVE

Well, we didn't have a high degree of confidence in that because we'd seen some logic glitches in the BMS before going run. And it was the same in the 1-13 in the first

sim; that had its logic problems, and just a simple micro-switch could bomb it out to where you can't even use it. And if we can look at the status indicators on it and see where the problem is, you know, well, we can bypass it or go right to it. I don't have - you got anymore in the WCS and BMS?

SAWIN It takes target practice.

CLARK The human factors aren't quite right on that seat, I don't believe.

MUSGRAVE The hole is pretty small, on the seat.

CLARK And also the seat itself is difficult to clean because of the material it's made out of.

MUSGRAVE But on the other hand, the smaller you get the orifice, the more air flow you're going to get directed in the zero-g environment to start moving things down where it's got to go. In this case, we had gravity helping us. We weren't dependent upon the air flow.

SPEAKER Story, one final question on habitability. Did you have any need for any time away from the experiment activity for yourself, exercise or whatever?

MUSGRAVE Exercise. After the last one, we thought that for 7-day mission you should not flight-plan exercise. We had flight-planned it on the first one, and we didn't use it for exercise. But I'd say that you always ought to provide equipment for the person who wants it. No matter how short the mission, you ought to have exercise equipment onboard. I personally don't feel that you ought to flight-plan it on a 7-day mission. I think, when you get to a 14-day mission, you ought to have it in the flight plan. That's sort of a feeling, and Joe Kerwin agrees with this. Bill, you got any comments on that?

THORNTON That's probably true - 5 to 7.

MUSGRAVE Seven-day mission you don't have to flight-plan it, but I think you always ought to have the equipment there, even - No matter how short a mission for the person that's got a feeling to get on it. Now, I'm one that likes to exercise an awful lot. In terms of leisure-time activity, I like to go back and run things back there. Get back there -

that's kind of my off-duty activity, go back and run something.

CLARK We'd be running something, we'd occasionally have a tape recorder going. Occasionally have a tape recorder going while we're eating or something like that. Did use the calculators for the experiments, at least I used the one up top quite a bit.

GOULDING Did you say - you say you used the tape recorder?

SAWIN Yes.

GOULDING Did you use the blank tapes for recording anything?

SAWIN No.

SPEAKER I have one more question, those little tote bags, did you bring anything in?

SAWIN Yes.

CLARK Yes.

GOULDING Were they useful?

CLARK Yes.

MUSGRAVE Yes, that brings up another thing. We kind of grabbed - at the work bench there we grabbed two drawers, two little drawers for each crewman. And this was a recommendation I had on the last sim. As you're training and getting into things, you develop a need for some little items to get the job done that aren't on the stowage list. And it's hard to go through the stowage mechanism of how are we going to get this thing on the list. I think the crew needs a - I mean, you know, the drawers are only like this, but it's drawers that belong to the crew that - for those peculiar things they need to get the job done - that they can go and stick them in this spacecraft and they'll stay there. We need that kind of mechanism. Like I had pens and data pads.

SAWIN I had some car keys I couldn't find.

MUSGRAVE But, as you go along you develop things, which are handy to you to get the job done. And rather than going through

the mechanism of getting it on the stowage list, it's easier just to stick it in there.

GOULDING Did you use your stowage list?

MUSGRAVE I never used the stowage list.

CLARK We went through that review; we knew where everything was.

SAWIN The lockers were labeled externally in the mid-deck area, and that helped.

MUSGRAVE If you really have to use a stowage list, it's really going to eat your time up, because of the hundreds of things you've got to go find. Like we covered this morning, the really good stowage review is a high-fidelity stowed one-g mockup where you can go through and pull out every drawer and etch in your head. And the sooner the experiments get up to high-fidelity stowage, even when they're not in the Spacelab, even when they just got their racks there. As soon as they possibly can, if they'll start putting in those drawers what goes with that experiment, that's when the stowage training begins. I guess that's it. Are there any other OTR's we haven't covered on habitability and - -

CRESS I think there's a few here, but I'm not sure that the right personnel are here. If you'd like, I'll just run down through them; we could use it as a checklist to see if we might have missed anything. Medical monitoring and the medical kit. I don't think you all use that too much, did you?

MUSGRAVE . . . blood pressure and that stuff. If we had someone who was sick, we had an extraordinary capability in the experiments. And much more than we ever used. In fact, that's the point I was going to - I'll make tomorrow. And that is, you really make the big breakthroughs when you take one subject and you can correlate different parameters. Like, we had the cardiovascular set and we could be taking data there but we also could have brought the hoses over from your experiment and simultaneously have gotten all the cardiovascular stuff and added the cardiac output. Things like that. But for anyone who is sick, the experiments had a lot more capability than the - of course, and we used that instead of the medical kit.

CRESS Had Ben's CRT. OTR, I guess you got a couple of pictures.

MUSGRAVE Bob can address that. He used a Polaroid. Are you talking about the Polaroid?

CLARK I don't know if you still have it there with you, but we took copies off - took the - the hardcopy device would be just a rod and a Polaroid camera that we used for X-21 experiment, and moved it over to the GDP and set it up on the GDP and - -

FERGUSON Did you have any trouble setting it up on that other terminal?

CLARK Did I have trouble setting it up on there? No. I took the modem and set it on top of it to balance it. But took one of the day's flight plans plus the shopping list, so there were seven photos, and pasted them all up and had a neat little flight plan, about like so, that was all Polaroid. It took about a total of 7 minutes to call it up on the GDP, take the photos and paste it up.

SPEAKER Of course, we didn't do this; that could be standard ops for OFT the data. All that data we'll be sending up. There's no other hardcopy right now.

CLARK Thermal hardcopies, are going to eat your lunch on power, and possibly this is a good way to go. But the bad part about Polaroid hardcopy is we took a lot of photos for our experiment with Polaroid hardcopy, and there's a lot of trash that comes out of there. For the photos that we took for our experiment, it took three dry trash bags for the waste from that.

MUSGRAVE I guess the battle we've already lost. I think we ought to have hardcopy Orbiter capability. The Skylab, if you look at some days, we send out 20 and 30 feet of teleprinter pad and now we say we don't need that. The teleprinter was - that was way back historically, that was something that it wasn't required. It turned out to be crew optional item that the crew wanted teleprinter. We were asking for it and it was an optional item, you could do or not do. There was only one set of electronics for it because it didn't matter if it failed. So that's - but yet, we sent up 20 or 30 feet a day. Horrendous amount of stuff on there.

CRESS Really depended on that thing.

MUSGRAVE We really depended on the teleprinter and now we don't have one.

CLARK On the things that we copied, we had the flight plan updates, we had the shopping list, we had the changes to procedures, and just on scratch-pad notes, it had to be up linked. There were some 45 pages that came up on that. So it was exercised quite a bit.

CRESS And we didn't even change the flight plan until day 7.

FERGUSON We sent quite a bit of data up.

MUSGRAVE But you get into astronomy experiments, and Earth resources and those things, that you can't plan in advance. You know, you've got little changes to the orbital characteristics, and the times, and all that stuff. I just don't think Polaroid is going to hack that kind of usage.

WHITE Story, I'm not sure who's doing it but there is another system they're looking at, a facsimile uplink system.

MUSGRAVE I really think we need it.

WHITE We've been asked in life sciences to see what our requirements are.

CRESS I think we'll have some by the time we reach the operational era.

MUSGRAVE It would be nice for the data that we look at on the CDMS, to be able to hardcopy that. And that's, you know, a bird in the hand is better than ten in the bush. And then you've got data, hardcopy data.

CRESS I think it would just be for OFT . . .

SPEAKER We sent several types of data. One time was when you got the whole checklist page as a change, the other time was when you got the very small Orbiter CRT size.

CRESS Number 4 was personal hygiene; we covered that. Five was housekeeping. Six was mid-deck utility. We wandered in and out of those pretty good. Seven and eight were waste management system and the BMS. I guess maybe we'll get with Dick later.

MUSGRAVE We hit them pretty hard this morning.

CRESS Potable water, 4 ounces. I guess, that's the extent of that one, except for the food.

MUSGRAVE In analyzing the water, again we put it out over the loop. And looking at the wastewater we generated, there was very little of that usage on that log because most of the time you were putting the washcloth in there and soaking it up, and you never used the wastewater system. Very rarely did you use the flow. You wet something and washed with it. And that water, of course, will end up in the spacecraft ECS or the trash, either one.

WESTOVER We had real high readings. I couldn't figure that out.

MUSGRAVE You what?

WESTOVER Had quite a large quantity indicated.

CRESS We were getting higher quantities than what you indicated you were using.

MUSGRAVE The flowmeter was left on a few times. Is that integrator stable enough?

WESTOVER It could indicate a higher flow than - -

MUSGRAVE When we left the flowmeter on but weren't using anything, was it still tabulating, would it still - -

SPEAKER Yes, usually you could tell, but it would be a pretty steady straight line type curve.

CRESS That's a drift, really, on our flowmeter, isn't it?

MUSGRAVE 64 liters. . . . urine, water, . . . PHS. 64 liters.

SPEAKER Yes.

MUSGRAVE Urine and PHS.

SPEAKER Right.

MUSGRAVE And the urine would come to in the vicinity of what. At least 4 liters a day times 7 is 28 liters; 38 liters of urine. About half and half I'd estimate.

CRESS What did your flowmeter indicate?

WESTOVER

CRESS That was the actual volume that you measured.

CRESS What did your flowmeter indicate?

WESTOVER We didn't have it calibrated that high.

WESTOVER Did the little personal hygiene water dispenser drip water all the time?

MUSGRAVE No. I never found it leaking.

CRESS Soap dispenser. Did it leak anymore?

MUSGRAVE Yes, it did on a recharge. Chuck found it leaking strong. When it recharged, it leaked again.

SAWIN It spurted out. It was just for a short while, not with large volume.

MUSGRAVE I guess that valve was pressure-dependent.

CRESS Still feel that bar soap is better?

MUSGRAVE Yes.

SAWIN I don't know about that. It would be nice to have as a backup.

MUSGRAVE You could have a hand dispenser, you know, like a mustard bottle.

CRESS Seems to me you're just asking for trouble, though. That system right there has a potential of fouling up the system like it did on day 2.

MUSGRAVE That could be really catastrophic.

SPEAKER . . . One of the reasons for the test was to check to see what the centrifuge could handle and if the soap was an impact was one thing we wanted to find out. Apparently it didn't because we operated all the way through the test without any problem with the separator.

CLARK How much soap did you estimate got in that system?

WESTOVER Quite a bit that one day.

CLARK What?

SPEAKER That one day when Chuck saw it coming out. It could have been quite a lot.

CLARK The first day when we tore the . . . I got quite a bit of soap out of the line when we took that line off.

CRESS That one on training flow but you hit that this morning.
 . . .

MUSGRAVE Coordination was outstanding. I've got a tally of how many total hours we got. There was a shortage of what I call mission training where you are in there running everything. It was really wild. When we first got into the racks themselves, there was a whole bunch of people and the integration process was still going on. The equipment wasn't working. When we got in the lab itself, there was a whole bunch of integration still going on but the tight schedule, we didn't want to kick anybody out. So we kept going. And I felt that on launch day we had a shortage of mission-type training; we only had 2 days, the 2 days of integrated sims. On the other hand, you look at performance - you guys are better evaluators of that than we are. But, from day 1, we sure zipped through that stuff, so you've got to say that we were ready. We had enough. So the approach and the process worked. If we were flying a real mission, I would want to get more in terms of the systems training and a little more depth, especially talking to the computer programs and that sort of thing. It all worked for us and we had good support from the ground. But there are areas that I'd liked to have gotten a little more.

CRESS We would have liked to have a little more systems training ourselves because we just, thank the science room and the PI's, if you had the right individual there at the right time. When you had a problem, then we could cope with. But we had a log of single-point failures on the ground as far as knowing the systems. We just didn't have too many problems.

SPEAKER How many hours you figure you actually trained?

MUSGRAVE I've got to do the dog work and go back, and I've got another green book, got that green book, but I've got

another one that's got each experiment and how many hours and each type of training is in it. I tallied it all for the last one and it would take me weeks to get it out for this one. It's one thing when you are scheduled to get the training, but you get a lot of training that isn't scheduled. You stay late or you leave early. Or you come in on a given day and you get finished with something early and then you jump over and join some other PI that's there working on his payload and you train with him awhile. As just a rough hack for now, I still think that for this type of mission that 350 hours on payload is a reasonable time. 300 to 350 hours of - that's exposure time. It's not homework, it's not anything else, it's just plain exposure time to those experiments. For like the payload specialist and the mission specialist.

CRESS

Had one on the radiation monitoring, but I don't know that we did anything except monitor the readouts there.

CLARK

The readouts that were used in the test were Gemini monitors. I think that we've ought to have something a little more state of the art than that these days. It should be looked into for the next test for a total radiation monitoring system, a portable monitoring system, especially it's going to have to be required if you're going to use liquid isotopes onboard. I think the whole radiation aspects of availability of radiation-monitoring equipment has to be looked into for any future tests, especially life sciences tests that potentially involve isotopes.

CRESS

Two more flight plan concepts which we covered this morning, and food system which we covered. And we've got one carryon concepts. I'm not sure which one is a carryon. Did we do that?

MANGOLD

That was on the cardiovascular.

ALEXANDER

I wish that Bill were here; it's Bill Huffstetler's OTR. But he and I talked several times during the mission about the fact that we launch with empty racks, especially up in the oblique part of the BUD racks. And it looked to us like that if we had loaded 20 more experiments onboard that required very little or no crew time early in the mission but would be there for you to use when you got into a situation like we did late in this one, that that would have been a good thing for us to have done. The only thing we could figure that would bite us there is

that when we get back to the ground someone would say that we didn't accomplish our objectives if we didn't run all of them completely. But I think that we could legislate that in before we start.

MUSGRAVE

You've got to look at the other constraints, of were we over gross. You know, when you add the pallet and the CRL and all our stuff, we're probably over gross. So you'd have to look at weight constraints and power constraints, you know, whatever else. Obviously there was plenty of space left over. But that's a decent data point, more space left over.

SPEAKER

How much does that Spacelab weigh? You have any idea? I wonder if anybody has the weight.

SPEAKER

You know we talked about this this morning, the possibility of taking them out and weighing them.

CRESS

You know, you've got up to 32 000 pounds, and that includes five.

CLARK

Shuttle - basic Shuttle weight. Our concept is five . . .

CRESS

You've got that configuration capability, it's just - the weight might be marginal. And the c.g. . . .

DELUCA

That's right. You've got the configuration versus the c.g.

CRESS

If you ever flew anything like this, you probably wouldn't have a power problem even though from an efficiency point of view you'd probably want to run one shift. It may be other constraints that dictate that we'd have to run two, if we flew something similar to this.

ALEXANDER

You got to run two shifts with seven people. Anytime you fill up the bunks that are available, you're going to two shifts by definition.

SPEAKER

How would you think about sleeping in a bunk that a guy had just slept in.

SAWIN

We did it for a week (laughter).

MUSGRAVE

For a life sciences mission, I'd run seven people single shift too. Take a sleeping bag and hang it out in the Spacelab. Hang it anywhere. As a biological subject,

some guy who's had to shift his circadian rhythm on launch day, then he goes through that two-shift environment, he's a lousy subject.

- GOULDING You'd vote against a two-shift operation.
- MUSGRAVE Especially for life sciences, when there's animals, plants, and everything else. They can't be studied 24 hours a day. They need a break. They've got to have a day-night cycle and all that.
- FERGUSON Story, you were usually ahead of the time line. In fact, we did readjust the time line every day real time. Did it bother you, or did you prefer being ahead, or you didn't like the time line where it would have been everything was move densely scheduled.
- MUSGRAVE Changing the time lines? You were changing the time lines?
- FERGUSON No. Real time. Had you preferred the ground give you a time line every day. Very densely scheduled.
- MUSGRAVE I'd much rather be ahead. If you're behind, you can't exercise real-time flight planning. The only thing you can do is move on to the next thing. When you are ahead, you can say, I am ahead of what's being asked, I can stick this other thing in there. My recommendation out of the first one, you've got to be ahead to really exercise real-time flight planning. And I think that one thing that really allowed us to be that efficient was to juggle things.
- FERGUSON We had - you got up early, you had, you had several pads, and eat periods for pads housekeeping . . . I just want to know if you'd like to have more pad in the flight plan that you launch with.
- MUSGRAVE No. There was too much, actually. There were some things that people wanted to get and you couldn't give them on the flight plan, and it would've been nice to be realistic and say you're going to get this. But like the cardiovascular was, we were - Right up to integrated sims, we were still developing. We never had a chance to run that where we developed all the methods. So it was taking time. And it would have been nice to kept everything on it that people were asking for. It would have been nice to be a little more realistic. But it wasn't until the first day of integrated sims that we were there on most

experiments. Some were being run all up for the first time. It is nice to be realistic, but I think if you can, you can stay ahead to do the real-time flight planning. And some people aren't going to want to cheat on sleep and eating. Some people need 8 hours and they are going to want it, and their performance is going to fall if they don't get it. We really felt bad that first half an hour. You felt bad, Chuck? It was just horrendous. Around the 4th or 5th day when you woke up and got up, man, it was really bad. But it only took about a half hour or hour to really get running and feeling super. I don't know how we got turned around so fast.

SAWIN Bob's cooking (laughter).

CLARK It's kind of bleak to get up first thing in the morning to go out and stand nude in front of four cameras (laughter).

MUSGRAVE But at least he was up and running and - -

SAWIN Sit on a cold scale (laughter). No amenities.

MUSGRAVE You had to get up early on those days, 2 and 4. When you're running the stereometric and when you're running the cardiac output, and that dash 11 - that's because we didn't have parallel training. It turns out that there were several times that one individual, in that case, myself, would be the driver. The day isn't really going to get underway until that guy gets done what he's got to do. If we had the luxury of really parallel training, and having Chuck load some rotors two would be processing, plus we could have worked around that a little bit. That's onboard flight planning, getting started early on something.

CRESS We probably ought to talk about the aft flight deck operations some.

CLARK The main complaint that I've got up there was the writing surface, which somebody mentioned has been taken care of. There is a definite need for stowage up there for experiments. As I understand it, the area where the power distribution boxes on this sim were located, there is some area there that's available for stowage. But it is highly desirable to have some area there that you can use for stowage of equipment associated with your experiment. Lighting in the aft flight deck; there were five lights in there but, from the light levels they give out, you

could only use one of them to get the baseline light level as it is in Shuttle. Our experiment, with the types of controls and displays that we used, I never even had that light on. There was plenty of light coming from the high bay area. So that would be necessary to have that one light and it was totally adequate for our experiment. For other types of experiments, I'm not so sure they'd be sufficient. I can't think of anything else up there.

CRESS Need any more handholds going up the ladder?

CLARK No. That's probably one-g problem.

CRESS Oh, it is, for this facility.

CLARK You may also need something to grab on to even in zero-g's as you come through, but I'm not familiar with that.

MUSGRAVE We turned Dr. Kerwin on to that thing. At least have him put his zero-g experience to take a look at that as he goes out to Rockwell this week. That's a traverse you're sure going to make an awful lot of times is through the interdeck access. So we put him on to that to take a look at that.

CRESS May not make that traverse as much as we think, you know. . . .

MUSGRAVE They are going to be working in the Spacelab half the time.

CLARK Well, the one-g problem of getting up and down the steps, I think, is just a question of getting used to. It's got to be a decent trip where you didn't have any problem getting up and down.

WHITE For our one-g facility, would you recommend any mods or not?

CLARK No. I think it was good. The position of that handrail that was put in there at the last minute was just right.

CRESS Did have any problem making noise going up it where - insulate that thing or put rubber around the ladder or something like that.

CLARK Didn't notice any problem with noise level.

MUSGRAVE You ought to have a curtain you can put across it.

CLARK That's a good point. To cut out the light from - -

MUSGRAVE To cut out the light and also the air-to-ground transmissions and other noises coming from up there.

CLARK Both hatches are open on the Orbiter configuration. But one of them was closed up for this test, primarily because of safety in operating over there on the payload specialist station. Several times before that was closed up, it got rather scary of things falling through the hatch and things like that with people working down below there. For use in this simulator, I'd recommend it stay closed up if you could get by with it. This one-g, you have a real potential. Things have dropped through there. For example, one of the handy talkies fell through there one day, missed a guy down below by about 2 feet. It ought to stay closed up for one-g.

MUSGRAVE An occasional wet trashbag dropped down (laughter).

SAWIN I want to discuss that use of the aft flight deck, the outhouse concept.

CLARK Yes, the outhouse concept. Privacy in the aft flight deck was used.

MUSGRAVE Open the lid and hit it from right up there.

SPEAKER Bob, . . .

CLARK You've got enough air up there as long as you don't use it for the outhouse concept (laughter). There is enough air up there. The problem initially was just the temperature in the high bay, I think. With that blower that's back there behind the payload specialist station it seemed to keep the equipment cool enough. Without that blower back there, it was building up heat pretty bad there when we first put our gear in.

SPEAKER . . . moving the air out in the mid-deck.

CLARK The mid-deck seemed comfortable. Except on the next one, since the Orbiter does have vents that go into the bunk areas, you might want to consider that for the next test. It got a little stuffy in there all closed up in the curtains.

CHASSAY Did you all have a need for use of your flashlight in there?

SAWIN Yes. Check the depth of the remaining stowage in the WTS (laughter).

SPEAKER Did you have any possible reason while you were in your bunk for the flashlight.

MUSGRAVE In the bunk?

CHASSAY Yes.

MUSGRAVE No. But occasionally, looking back in the racks up in Spacelab.

CHASSAY What flashlight did you have there?

CLARK Used that little pencil flashlight.

MUSGRAVE Used the penlight.

CLARK The penlight, carrying that around when the other two guys are sleeping so you can see and find yourself a cup of coffee or something like that was real handy.

CHASSAY Just had one of them?

CLARK Pardon?

CHASSAY Did each of you have one?

CLARK No, we didn't each have one.

SAWIN Got to tell Rita the classic story. Bob, on about day 5, walks out and he says, well, we've got a real problem. We got a coffee shortage. Just inventoried the pantry, we down to 15. And he says, guess I'll go back and make some coffee (laughter). So we're all wired up and can't move (laughter). There's another thing in there, I - doctored up one of the shopping list that came up on the GDP. Ben sent up the shopping list for day 6 and, using GDP, you can add things on there and you never can tell the difference of whether it came from the ground or not. So, I put Story on for an extra 9-C and for running of vestibular function and also for doing a sampling for the chromatography, the wet trash stowage (laughter), and he thought it was real (laughter).

MUSGRAVE It was all reasonable. I thought it was real.

SAWIN He's reading them all back down to Carter - -

MUSGRAVE . . . for Carter to work out when we're going to do all this. Carter must have thought I was out of my head.

CLARK Another thing, too. I think some of you guys thought that we must have had a radio onboard or somebody was feeding information to us for me giving the daily weather forecast for Houston as we passed over. Actually, what it was, there's a pressure sensor on our payload back there and I was taking the pressure changes and coming up with a weather forecast.

CRESS Are there any plans for the future for adding on the aft flight deck? Like adding a front end to it.

SPROSS No plans. Just all depends on what's coming up in the future.

WHITE If you've got some requirements, transmit them.

CRESS No, I think, I was just wondering . . .

CLARK For our experiment operations, Story addressed this earlier, it would have been extremely advantageous for purposes of implementing our experiment to be able to have a pilot and commander onboard to do a lot of the functions that these guys had to do. The pilot and commander being on the flight deck would be the logical ones to do the monitoring functions, the SAA's, and the other things. My recommendation would be as it's been in the past on the other sims, to have a commander and pilot involved.

SPROSS I think, as this facility evolves, things like this will come up; we'll get more people involved in the facility in these type tests. I can envision us doing something like that.

SPEAKER Another thing that happened, it occurs to me is the camera controls. It's our system here.

CRESS You get enough Orbiter systems, it would increase the fidelity for that aspect. Of course, that would cost money.

MUSGRAVE We can start with just paper planning. Say the CDR, give him 100 percent of the Orbiter like we started out. And have the PLT more involved with what's going on with the CRL and the Spacelab. Just paper plan one of the crewmen. You just can't get people to perform right if they are just sitting there for 4 hours saying, I'm doing Orbiter functions but I'm not going to do anything . . .

WHITE I think that's more or less going to be up to the FOD sim people. . . . Those things are real easy to implement because you can just put a fake switch out there that turns the light on a sim guy's console and he can make the system respond, or something like that. I think it would be manual-type things.

MUSGRAVE Yes, but the motivation is really lacking when you got a dead machine where there's no feedback.

CRESS There's certain things than can be done by . . . There's certain management of the comm functions onboard, the data-handling functions, the onboard computer, TV system. The comm system for Shuttle is a fairly complex system and that has to be managed to some extent. The only thing we'll do on the ground, I think, is dump tape recorders and things like that.

DELUCA Even though that would be a normal operation, if we have the capability to use an onboard recorder for taping and dumping, TV manipulation, things of that nature. Those could stack up to a task for the test. Even though some of that would be done by the ground, but for this purpose, it would be - -

BRADLEY For certain purposes, we assumed that the FR-2000's were onboard recorders and we had a man there to operate them. . . .

CRESS We had DR status on this agenda, but that's going to be covered . . . tomorrow. That's all the agenda items that are . . .

MUSGRAVE We covered an awful lot of training and ops this morning - Integration this morning. Most of the DE managers were here for that. You got any more on facility?

CRESS There's probably a lot of things I'd like to see done to the facility to increase the fidelity, both the mockup and the ground system. I think that's just a matter of

time and evolution and money to get those sort of things done. Just increase the fidelity of the whole facility. Comm system, TV, data system, get us some telemetry on the Orbiter systems.

WHITE

The question came up this morning about do we see any point in keeping system part of the facility configured the way it is now for some possible mini sims, and I think the way that was answered this morning was, yes, we got a few systems things going, but the question is there any need to get other ops teams in there and get other evaluation of that ops from the aspect of it. That would come from you all, not from us. If you all had a desire to - if you want to look at it some more.

CRESS

You were putting a schedule together, I understand; long-range use of that facility. Is there any - -

WHITE

All I've got right now is what's on the RTOP.

CRESS

I wondered what the plans are for test III. When . . .

SPEAKER

We've been talking with Ames about that, but right now all we know is anywhere from 6 months to a year from now. Somewhere in that range.

CRESS

If it's at least 6 months, what's the hurry to get it . . .

WHITE

I think that's one of the problems in anything - we're talking about one-of-a-kind gear . . . The PI's want it back in their lab.

SPEAKER

We'll answer that tomorrow. Don't worry about it.

CRESS

I guess unless anybody else has any more questions, . . .

#

SCIENCE EXPERIMENTS DEBRIEFING

ALEXANDER

We're going to start the science debrief at this time. The schedule we're going to go by is X-1 through X-20 and then reconvene at 1 o'clock to do X-21. This was a late change in our thinking and in our scheduling to accommodate some meetings that our division staff is required to be in, and also because the X-21 people had some other commitments this morning and they either wanted to go early or go at 1 o'clock, and I certainly agree with that. So if we complete our life sciences work by noon today, we'll just reconvene at 1:00; if not, I think we'd better go ahead and do the X-21 at 1 o'clock and then pick up where we left off on any of the life sciences experiments. I see no reason but to go straight in order starting at the top with X-1 and proceed on. We should be able to finish this by noon. If we do that, that means we can spend approximately 20 minutes on the average with each experiment with the break somewhere around 10:15 to 10:30. Story, you guys, and Chuck, Bob, proceeded yesterday with the other aspects of the debrief; I think that's the way we'd do it today. We'll just start with the announced experiment and you guys start talking. I have no objection to talking about the cardiovascular block in toto, if you want to do it that way, since it was run pretty much as one large experiment.

MUSGRAVE

Okay, I think to start off we'll get done by noon because there isn't that much. It's a credit to all of you that . . . that much. We could run in the Spacelab right now today and everything looks perfect to gather real data. In other words, we didn't have an even near catastrophic failure in any experiment. You know what the performance was; you got the computer printout of what got done and it just went - from right day 1, it went just as slick as a whistle. Nothing broke; everything got run as many times as it was supposed to and many times more. It's a real credit to the type of hardware you provided us with, the type of procedures you gave us, and the integration of the payload into the Spacelab. This thing really could have flown. I think that's a summary. You know what was accomplished and that stuff is running today. The whole thing was beautiful. That really stands for

every single experiment. In fact, it's astounding that you can take hardware that is that complex. Now we had a good payload the first sim but I think one of the big characterizations which make this one different is the complexity of the hardware. Even if you look at the total medical package on Skylab, the complexity of this hardware is 2 or 3 times more complex, more flexible, and more capable than the total medical package on Skylab. And every single bit of it worked.

DELUCA Before we go much further, the question came up yesterday about the CDMS capabilities in terms of recording. I'd like to point out that the CDMS mass memory stowage at this - at this time is a "read only;" it only contains the programs to call out to do things with. We have no on-board recording and stowage capability for return planned.

MUSGRAVE So, it's either the experiment or telemetry. Storage on the ground.

DELUCA That's right. Now there's a movement when you try to get it to write. But I don't know whether that's going to float.

MUSGRAVE My guess is most experiments will probably have their own onboard storage capability, but like we did this time have a parallel output to the ground so that they can see what's going on on the ground. That is a general philosophical question. We had been going toward onboard storage only. It's . . . in the last couple of years, but this one there was an interest in having a central data stream so many of you went to that as well. But you can see how much you helped us out on the ground being able to see what we were doing; not only the TV but also the data output to the ground, especially when you have qualitative aspects of the data - is the data satisfactory. You could help us out if we weren't getting it all or if something wasn't quite good enough. So there's no doubt that on the ground you can help us an awful lot by looking at the data down there.

DELUCA You brought up something else yesterday for the next sim about more hardware-type problems. Those can be better simulated if you anticipate from hardware some telemetry for health and status and all that kind of stuff. If we can do something about that in the future, we would be able to handle more - have a better interface for sims

than to introduce problems that cause you to take some other actions.

MUSGRAVE Yes, you could have - sims do have - you could have a period in the evening or whenever, mid-morning, early morning, like 2:00 or 3:00 when we get out of the Spacelab and it's his. And he could come in and put in minor physical problems with approval of PI's and that kind of thing. We sure didn't think we needed it. The last sim we had plenty of malfs to work and this time technical malfs, there just weren't enough. And the ones that we did have, we shot them down - we really tore them up in about 5 minutes and we got running again.

DELUCA I think another thing with respect to technical-type malfs is we didn't culminate until rather late in the game and then the sim world usually precedes even the operational world in terms of planning malfs. It takes a long time to arrive at the kind of things you want to do technically because you just can drown something terrible if - -

MUSGRAVE No one took the need seriously. We looked at the last of the history and the need wasn't there. So it turned out to be . . . Especially we want to hear from everyone in the room; we don't want to dominate the discussion here, so anybody that's got any points on their experiments in general, ask questions or go ahead and say it.

MERRITT One thing on malfs. . . .

SAWIN You have a read head but you don't have read produce FM modules for every channel, so that's your problem.

SAWIN In terms of hardware for the cardiovascular series, you know they were a little bit pressed just as all of us were to get their experiments ready. The one thing that we had to watch more than we should have had to was the pneumograph, and it's because it's critical to some timing events in some of the experiments and because the air-conditioning flow impacted it completely. Everytime that air-conditioning cut on, it would bomb that reading off scale. I think if they had to improve one item, that would be the item to try and get something that didn't have such a baseline shift. It would still give the data that they need, which really means electronic redesign, more than likely. As it worked, we just had to watch it awfully carefully. We had to be reminded sometimes; we'd

get doing a couple of other things and obviously the person monitoring it down in the science area would see it go off scale. I think that was the only thing that really caused - -

MUSGRAVE - - Joe Baker (?) - -

HOFFLER - - Joe's not here.

MUSGRAVE You could get that off the VCG electrode . . .

HOFFLER Possibly, Story.

MUSGRAVE Two axillary electrodes. . . .

HOFFLER . . . We'd like to look at another basic sensor . . .

SAWIN The basic sensor may be alright, Wick, I don't know if it can - I'll get out of my element in electronics, but incorporated circuit design says you don't have a big baseline shift. You'd still see your amplitude changes due to respiratory patterns, which is what you want.

MUSGRAVE We just have to keep after it, it wasn't any big thing. We just had to be sure that our attention kept coming back to it.

SAWIN That was one of our standing jokes. I was in charge of - I was PI on the pneumogram experiment and I had to watch that thing.

MUSGRAVE You get it far enough away from the nose, that kind of helped. But the air-conditioning was a factor. When we went to the FR-1300 we routinely turned it off to be sure it wouldn't blow. We called it the hurricane because it was really windy in there.

HOFFLER . . . we can get a better device for that. It was just a function of the haste we had to put together everything on this.

MUSGRAVE But it did it; it got your respiration. We just had to keep after it a little more.

SAWIN It works. But perhaps just a different way of shielding it from the ambient air flow, something as simple as that. It worked really nice.

MUSGRAVE It's really a credit to the system. We sort of singled that out, because otherwise, you could almost leave the

thing running and go do something else while it was running. Nothing else really required that much persistent attention. It would have been real nice if we had been able to route the input of the echoscope down to you all.

SAWIN Have you had a chance to look at any of those strip charts? Are the images that you were looking for there in most cases?

HOFFLER In most cases.

SAWIN Not all of them . . .

HOFFLER You know that the day you put the TV camera on you could see that the height was very nice. It wasn't as clear and as long persisting as the . . . but it was . . .

MUSGRAVE The training we had, we'd liked to have had a definition of the task. I felt very uneasy for many weeks here maybe a month. I'd like to have an earlier definition of that task. Both the equipment itself in terms of what things are absolute you can set the numbers into the index or that kind of thing, and what parts of it were really controllable and needed to be controlled by the crew to get the right image on the recorder. And as you know, what you're seeing on the CRT doesn't always match up that perfectly with the performance of the recorder. And so, we flagged that as something we really needed for some time and quite late on you know we had that one super day when I felt I went from zero to where I could knock it off in 2 minutes. And so I'd like to have gotten there a little bit earlier . . .

HOFFLER Apropos of that, Story, I'd like to say that the logarithmic . . . slope of the learning of you guys on this . . . was phenomenal. I was more than surprised in this particular thing. . . . get together and you guys . . .

MUSGRAVE I don't like to rely upon that logarithm. I'd like to see a linear progression because, if you're getting down to the end of the line and it requires that, you cannot always get that. But on that whole block of experiments, they were really fun to run. The system was fantastically flexible and capable to do a whole bunch of other things. We didn't have too many combinations to the experiments but there's no reason you couldn't have combined a 9-C with all your cardiovascular stuff and gotten really

extraordinarily good exercise data; VCGSTI and all those other good things. You know, just run your things over to the bike. Or we could have met in the middle and brought the hoses over from the pulmonary experiments and brought the cardiovascular stuff over and really gotten a good correlation. At the same time you could have gotten the biochemical things with a dash 11. So if we had had a 30-day mission - we were starting to regroup and do a whole bunch of new things on day 6. But if we had a 30-day mission, we could think of all the combinations and permutations we could have come up with to really study things. Just hitting down, one - certainly we didn't have any problems with the arm controller and I guess there was some misunderstanding to fix it, I came up with. The ground was talking about not being able to get into those - access into those panels. Just took a board or something to get back there. I think we need to think about visibility and accessibility into the components and that's something we still need to work for and kind of get a baseline there. On one day, we had to go behind panels three times and I forget what the third was. Putting the ink in the chromatograph was one. Getting at the pots on the cardiovascular was another. But we really need - so many times there's a simple little fix. If you can pull that thing out and put a multimeter on it you can short across a pot or some other little tiny fix, or just seat the pots. Those adjustment pots, you know, they pull in and out. Maybe the pot wasn't seated down in there. I took them out and pushed them back down in there to make sure they were really well seated in there. And so there are times when just tiny little fixes will cure a catastrophic failure. I was speaking to a lot of people later on; they thought I took a 30-millimeter pot and adjusted it up so it would give 55, and I remember it was pegging full-scale high at 75. I noticed when I was running Chuck looking at those pressures it was up to 75 and I knew with that with his diastolic pressure that would be compromising the total blood flow and affecting the results of the experiment. I couldn't adjust the 50-millimeter one; some people thought I went to 30 and adjusted it. I couldn't adjust the 30 either. So I think - I don't know all the circuits, don't have any schematics or anything on that. I think whatever the failure was, it was affecting the 30 also. So the 30 was probably full-scale high also. But its full-scale high was only about 55, which is just what we wanted. So, once I saw that I could get 55 out of the

30, I didn't play around in there anymore. I shut it up and pressed on. But with the little bit of time I did spend on it, I don't think I could adjust the 30 either. But that was a very easy . . .

SAWIN

We had one other problem that we're aware of. After you look at the data, you may suggest others yet. One was the cable that went between the junction box attached to the gurney and the armband. And Joe and Story and I talked about it air-to-ground a couple of times. I think you might have been around then, too. Basically, it looks like the connector for one of the pins at the junction box perhaps had some buildup on it and it was resistance or something. The way it failed was you could not adjust either the null or the gain on the armband. Everything was high off scale. And by Mickey-Mousing around with it, blowing it out - and incidentally, Charles Chassay wondering what we might use in the tool box, tuner cleaner is real nice stuff. For cleaning connectors and things like that. We just blew it out.

MUSGRAVE

Kept taking it and playing with it.

MUSGRAVE

You could take it and play with it while you were looking at the gage.

SAWIN

Anyway, it never caused us to lose anything. Just caused us a little time during setup. That was it.

HOFFLER

I'd like to make another comment and ask you guys a couple of questions. I must accede to Arnold Nicogossian's early preference for TV. That made a world of difference in our outside monitoring of what you all were doing. It was another world above Skylab. You sat there and silence on the microphone. You know, where the guys can see exactly what you all are doing . . . almost follow you by the procedure, item by item.

MUSGRAVE

That came up yesterday. We were identifying a lot of operational needs for the TV. It really assists in about every experiment. The ground can critically assist you in what you're doing and follow what you're doing. They can time what you're doing. And they can see that you're doing it right or they can see the results you're getting and you can get your feedback right off. So we are, Lou and Glenn are looking at - going to make inputs to support TV for Spacelab.

SAWIN Sunday was not our best day or not my best day. It was a real classic because in doing the X-1, first of all, the little junction box on the gurney shifted one time and pulled the leg band loose because it was fairly short coupled. That was a one-time occurrence.

MUSGRAVE But the box tended to rotate. The way the box was attached to the gurney it wasn't tight enough. We ended up taping that. Putting a strap across it to hold it. It would tend to rotate down and pull on the leg band.

SAWIN The next part was really funny to me because I was a little tired and I started the experiment run and I was looking at the arm and leg blood flows and they were nonexistent. That was really strange. I heard the controller cycling and the cuffs pumping up. I looked down and both cuffs were on the floor coiled upon themselves sitting there pumping up . . . (Laughter.)

MUSGRAVE He looked at me and said, "I suppose you let me do that?" In the meanwhile I'm doing like a good cardiovascular subject for maybe the first time in 2 months and I'm totally flaked. But I made the best subject that day instead of trying to play conductor. I made the best subject. When he looked at me and said, "Boy, I bet you let me do that, didn't you?"

MUSGRAVE Questions.

ALEXANDER On the subject of TV, I'd just like to amplify what I said yesterday or a question I answered. Our choice from the ground of camera . . . was not predicated on the fact that it was color or black and white, it was because of the camera angle that it would give us when we were trying to look at a particular experiment. Again, it supports the concept that if we can see the operation and are familiar with the procedures, then we can really be an extension to you guys on the ground. But whether or not I see you in black and white or color, doesn't really have any bearing. In fact, the black and white camera had much better resolution.

MUSGRAVE It did on our monitor. It did outside, too.

ALEXANDER It was sharp and everything, but I can't really go to bat for the color, as much as I know a lot of people would like to come up with good justification for a color TV. Good resolution and good camera angle plus all we

said about not having to go to the AFD to change the color, being able to do this remotely, changing the zoom and focus. That's what's important to the ground. It's not important that your face is flesh tone. We learned also (I'm not sure that you guys were aware of this) about halfway into the mission that the colors we were receiving were built in building 8.

SAWIN Wasn't that only on the . . . X-14? They had put filters in that camera.

ALEXANDER Yes, I think they patched it. . . . I might be wrong.

SAWIN I think that's only . . .

ALEXANDER . . . their color wheel. Everytime they had something going through them and back to us. I know they did it on X-14.

SAWIN It looked like a flicker fusion problem when they first set the camera up. You know, you'd look through there and you'd see all these shadows and then they put some filters in there and they had to recreate the normal green coloration, is what I understand.

ALEXANDER Well, the neat thing was that we'd get a purple plasmodium one day, and a green one the next day, and never knew what you guys were doing . . . Then we found out that that was artificial buildup. But anyway, the camera angle and the ability to focus in on what's going on rather than whether you see it in color made the difference to us.

HOFFLER You fellows, toward the end, asked us for possible modifications or additions to the protocols.

MUSGRAVE I think Carter probably initiated that.

HOFFLER I thought it was a good exercise but I wanted to reflect it to you and say, "What do you think, as crewmen, you could have altered or augmented to procedures or just added outright to improve the data take. The hardware as it existed. . . . a corollary, what would you have altered in terms of the hardware, the measurement capability, the control, the monitoring, the - I already alluded to the maintenance and problem solving - And maybe even you all could put down some basic item of tools that you ought to have.

MUSGRAVE

Yes, we're getting all of that. I'd like - I know you couldn't because you were part of the central data stream. It would have been a confidence builder to, much earlier, have been feeding the FR-1300 and having you take it back in the lab and play it back and us to look at the playback, which we didn't see and didn't need to see. But it would have been a confidence builder to know that you ran those experiments end to end and all you guys were happy with what you saw. Now we were seeing the conditioned signal on the CRT but, you know, you'd like to know that the whole system plays and it plays right. It wasn't until just 2 weeks before going to run that we got that on the cardiovascular series.

SAWIN

As to a general response to the suggested alterations in the protocols, I think we look forward to it. And I think it's the way that Spacelab ought to be run. It was really a lot of fun to almost ad lib the experiment and to be told generally what you wanted and then to set out and try and do it.

MUSGRAVE

We were doing the modification to 2 and 1 just prior to getting the procedures up, and I think that's something we might aim at and as a scientist to tell the onboard scientist what their intent is, what principle they want to exercise, and let the onboard crew go ahead and get it. In other words, without necessarily coming up with very detailed changes.

ALEXANDER

I've remarked on that one that we spent a half a day on the ground building a 10° tilt procedure for you and you came up with the most obvious thing onboard in about what looked to be 30 seconds. We went through a lot of trials and our PE's down here really got after that problem and stayed with it until they solved it. But we never considered using the scale . . .

MUSGRAVE

You're working there without having a physical environment is tough. You know I worked 9 months on the ground trying to anticipate what was going on in flight, what was there. It's easier when you're there. You can see the physical environment and what you got to prop things with.

ALEXANDER

I was very impressed. You got a better solution - -

MUSGRAVE

But we came out with . . . three quarter inches, you know - -

SAWIN That was the funny part. Had the right geometry - It came out to be the same. But I was thinking - I know Bob was sleeping at that time and I was thinking I've got to pick that gurney up with him on it and do something with it. Doesn't leave you much flexibility when one man has got to pick it up and prop it.

SPEAKER One disadvantage . . . didn't have the . . . like we did have in Skylab.

MUSGRAVE Yes. I don't think you are when you get to flying. I anticipate the whole process will happen just about like it happened this time. Right out of the lab. You might not even have any training hardware, you might be training on actual flight hardware in the laboratory at the integration facility.

MUSGRAVE Yes. Yes. I'm sure it was. I think we get to flying, you probably won't. You have a Skylab, you know, training simulator that you But it all worked. The final result's there; it worked the way we did it.

SAWIN We talked about our logarithmic approach to being able to run the experiments. It was a two-sided thing. One, we had had hands on enough ourselves. Two, we never run it ourselves, totally. We always had someone there looking over our shoulders, being helpful but at the same time not allowing us to make a mistake and having to rectify it. Third thing, we hit hard early and you responded to it well. We had no procedures for a long time. We had a list of things, do this and do that, complete this and shut it down, and on one page, which grew into maybe eight pages. I guess we need the full detail earlier in order to be able to get down to the point where we can run with the one page later. You know, we had to learn all switch positions and why, and I think it's hard to understand that until you're the guy who walks in to somebody else's equipment and tries to do what he wants.

MUSGRAVE Let me turn on my tape recorder here just once more. I did it yesterday a couple of times but - I'll hit it just once more. I hit it every sim at least once. We hit it . . . in an ops team meeting earlier. When you run this cardiovascular series again, the only thing we looked at was the data log, because we did have to write down for the tapes and try to get it to the second when we started each run. So all we're doing is looking. We really need data logs for each experiment. All the data we had to

write down with a pen. If we ever looked at the checklist, say the last couple of days, for any of those experiments we knew the data we had to get and we knew how it had to be conditioned. And we'd just go up and put all the sensors on and go to the scope and be sure that we had satisfactory signals and then just write in the data book. We don't need procedures to cookbook something because we don't understand it and don't know it, we just need to define the task early. What does the guy want? And we also kind of used them, we don't have any schematics or anything, we use it to point out to us the kinds of questions we have to ask to understand the system so that we can get the job done. Otherwise, we don't really know what parts of the system were our responsibility to dig in and understand the system. And it is also, I feel a responsibility that when I'm operating somebody else's experiment that I want it run the way he wants it run. I don't want to just jump in there and fly it like I think it ought to be flown. And so, procedures are kind of an agreement between the flight controllers and the payload people and the crew. It's sort of an agreement how you are going to operate his payload and the kind of data you're going to get, and the kind of protocol you're going to run.

HOFFLER

That was really my earlier question. In the real world when you're in space, it may be that your judgment on the site to change a procedure would be the better course.

MUSGRAVE

It may be, but it takes communication when you're running somebody else's payload. Now it's different when you got Bob Clark flying his own experiment or you got Chuck here flying his dash 8. It's really different when you got the PI there with his own experiment. But I don't think when you're flying somebody else's experiment that you've got to at least share your scientific judgment with the PI. I feel a responsibility there. Certainly if you feel there's better science there you can sure discuss it. Change it there. Give your scientific input.

SAWIN

Story's already made the point, but it's very nice when there are enough signals, enough critical signals being downlinked real-time that Carter or Wick, if he were there, or anyone else could pass judgment on whether or not those were really suitable or if those were the signals that they wanted us to be going with. Once we had clearance, it's a piece of cake. Just turn on the recorder and go.

MUSGRAVE

I think the cardiovascular series really supports some kind of downlink . . . I think, it looks like people are going to have their own onboard data storage but that series really supports some kind of . . . , 10 does too, the vestibular, really supports some kind of downlink in terms of participation from ground.

DELUCA

I'd like to say something about that with respect to the crew keeping logs. The point being, voice is time tagged. You will need the voice recorder for certain things. You don't have to maintain a log for that time tag. The data systems will be time tagged. And if there are things like calcs that require time tagging, it's there. I guess the recommendation would be to reduce the amount of manual logging that has to be performed based upon having those capabilities.

SAWIN

I would say that there was duplication in the sense that we kept a separate log for the FR-1300 plus a log for the, say, cardiovascular series. And my own personal preference would have been not to have to bother with the FR-1300 other than in initial. He would turn it on to cardiovascular series and then let them go back and look at that block of time later and find their data. But I think it is very important to have that small log like I had for the cardiovascular because it keeps track for me of where I am in that series of runs. It's really - five things back to back. And by just a few little hacks, put the cal on, I remember I've got to put the cal on and then get 10 minutes of data and put down start time and every once in a while you go do something else, you come back and look at the clock and say I've got 8 minutes and I need 2 more. Myself, personally, I'm absent minded enough if I just voice record that I'd lose track of where I was, I'd be going on the comm link asking Carter where am I. So to get rid of as much duplication as possible, I would be all in favor of it, but I would not want to take it all away from hand logging some things like that, sort of milestones.

ALEXANDER

On this philosophy of how much downlink you have, I think it's appropriate to talk about when we lost our VCG-X on that day. It's the ground's position, and I think supportable, because we really hadn't a mission rule built toward it that we cannot go to run without VCG-X data from a flight surgeon safety standpoint, but we were going against the grain by doing that. Now if we didn't have downlink - -

MUSGRAVE

What flight safety?

SAWIN Yes. What experiment was there that concern for?

CLARK This was when we were doing X-2 in the chair. The day we lost VCG-X.

MUSGRAVE But it isn't flight safety to say you can't do isometrics.

ALEXANDER Let me just reiterate, the ground position was the flight surgeon in the loop - saying we can't go to run until we get VCG-X.

MUSGRAVE I'm asking the scientific judgment of that . . . I'm questioning it. In fact, I don't think it's reasonable.

ALEXANDER Well, we're not sure that we thought it was reasonable either but that was the consensus on the ground.

MUSGRAVE You know, at 50 percent MVC with the arm only, the cardiovascular changes are significant; they are certainly observable, but they are not dangerous.

ALEXANDER The X lead, though, in that particular patch panel configuration is the only thing we had on the ground.

MUSGRAVE I'm not talking about the data. You certainly want it, it's a required part of the data, but I'm talking about the safety. It required medical monitor.

SAWIN I would say, based on his prior responses, if I had no readouts onboard, I would know that he's not going to go over 200 millimeter systolic pressure, and I would know that it's just not going to be that big a strain for him as a subject. But I'm monitoring him on a scope there. Of course, it's nice that he has a patient surgeon down there but if we do have the problem in flight real time, he isn't going to really do much. It's going to be what I can do for Story as his monitor.

HOFFLER I guess the question boils down is not onboard monitoring sufficient to itself.

ALEXANDER Yes, and onboard judgment to follow that monitoring.

SAWIN During the 9-C for instance, which is the best strenuous physical exercise, I've tried to follow his cardiogram, to keep track of his heart rate, look for ST depression, or anything like that and there was none. So - -

MUSGRAVE That was a real-time call. In the past . . . we hadn't gotten blood pressure and VCG's during the 9-C's. Was a good idea. You get more exercise than they do.

ALEXANDER Dilemma still exists where the flight surgeon says no you can't go to run. The way the rules are written in the test ops plan, if he says no you can't go to run, you can't go to run, we voice this up to the . . . crew, go LOS, come back over the hill we find you running the . . . experiment.

SAWIN No, I don't think we'd started.

ALEXANDER Well, you've got the calcs on.

SAWIN We were just sitting there. We were ready to start.

MUSGRAVE We weren't holding back; we were pressing on (laughter).

ALEXANDER We had the calcs on, we just had to wait.

SAWIN We were real close.

MUSGRAVE We didn't get that message, I didn't get that message that it was - -

SAWIN I did.

MUSGRAVE Oh, you got it. I thought it was a data thing. That you ought to stop because that's required data for the experiment.

ALEXANDER We were aware that you had it on the 1300. We'd already played that game and said that we don't care. We have it down here from a data standpoint, we know that they have it onboard. It's been verified.

SAWIN I had an argument with Story. I monitor stress tests all the time. I knew what I was looking for and that - -

MUSGRAVE The crew surgeon, he's - If he says he needs it, that's it.

SAWIN He didn't, Story, but we were ready to start.

MUSGRAVE It's his decision. I didn't know that there was any delay.

HOFFLER The issue still stands whether you're going to allow an onboard test without ground monitoring.

ALEXANDER And if we don't have data downlink, it's academic to argue the point.

MUSGRAVE We need mission rules and I guess we had one and we shouldn't have run it. We didn't have mission rules.

SAWIN We didn't run it because - Carter came on the loop and said press ahead and that's right what we were ready to do.

SAWIN I told him we're stopping at 25 percent and we were there.

ALEXANDER We had negotiated the point during LOS and it was okay to run it after you came back. But when you guys went away - for the 10-minute period it was down.

SAWIN Yes, I understand what you were saying. Because I talked with Story about it. Not naming any person in particular but - -

ALEXANDER I probably didn't know - -

SAWIN We talked about the philosophy of did the particular person who might be watching it, know what he would want to see if you were going to monitor. Could we not press on.

ALEXANDER This was all done by telephone anyway. But it was a rule that we had to play the game by; that is, without this particular safety aspect, could we go to run.

MUSGRAVE I didn't understand that; I thought it was just - -

ALEXANDER Wick bailed us out. Wick's the one that was able to come in as PI and a physician and overruled the situation that existed and away we went.

ALEXANDER He just happened to be at Hi-Lo Auto Parts at the time the thing was going on (laughter).

MUSGRAVE How did you find him over there?

ALEXANDER We had a pretty good locator system.

MUSGRAVE The fix to that. Not the fix to it but being able to patch in the output of the 1300, the signal going to it the vestibular CRT. There's a lot of lessons in there. One of them was that Dr. Clark was instrumental in coming up with that. It just shows, the physical scientists, the PS, was working life sciences . . . fly them on a couple of them.

It just goes to show that you got to look at the final crew mix that you come up with. CDR, PLT, MS, PS's, and all that. And you don't know who is going to be good in what areas. So I just don't think that we ought to be looking too seriously at the way crew positions are being legislated as to what their functions will be, because you may have a CDR/PLT that is a doctor or electronic engineer or something like that. So much of this hardware was electronics, and bioinstrumentation, and data management. There may be a lot more participation of these people in the life sciences experiments and vice versa in other areas. I think there's a real lesson here. Also, it's a lesson in commonality of equipment to give you flexibility to borrow - if you have some kind of commonality, you can borrow from one piece from one experiment, borrow some gear, and get another experiment going.

DELUCA With respect to Spacelab, getting to that for a moment. The specs call for a reformatting capability by the experiment computer. And in a case like that, as it stands right now, it says you can go in with software and change the slot for VCG-X.

MANGOLD Yes, but we lost it at the RAU.

DELUCA We went through that to explain the situation. The point being if it turns out to be a master unit problem and you got a slot problem in there, then you can change the format that goes to the PCM MU by the experiment computer and perhaps do something about it. But that remains to be seen yet how much variability we're going to have in that. But that's the thought so far. Real-time reformatting.

MANGOLD It wouldn't have helped us here.

DELUCA Not in this one, no. The point is that there may be situations where that can help us.

ALEXANDER Well, I think you guys really jumped on that in a hurry. You got PS2 over there to work to build you a cable to get back into the patchboard. We had a pin allocation change on your patchboard that went up in a GEP which would have been a more permanent, probably liveable fix in that you wouldn't have to float around that cord or that cable that Bob built for you. The general statement on all the SIMSUP malfs that we had to work was that sometimes they were a little unrealistic in the sense that you could almost get there but there'd be the last door that they'd not

let you open. In this case, it was going back and tearing into a patchboard. That would have fixed it.

SAWIN

We did all of them but one of them. One of them was when Dick came in on about day 3 or 4 and said, "Okay, after this the FR-1300 will never come on again," and that would have crattered all - -

MUSGRAVE

It was an on/off switch. In playing the SIMSUP game, you get a card that says, "The on-off switch once off will not come back on again." You could get the rest of the day. I looked at it and interpreted, well I'm not going to turn the thing off today so I got all day today, but when I turned it off. But then you see, you need another level as to what the problem is, because if that really happens, it's very nice to pull the front panel off and take the soldering iron with alligator clips and just go short across the switch and you're back in business. But you read this thing, you say, "Well, what kind of failure is he interpreting?" Is it simply a switch failure where you can pull the panel off and go across the switch. But we explained to him that putting that thing down, that that was - well, he was losing a lot more, he was losing all the primary data knocking all of that out. I guess that's the only card where we talked him out of that one. That's the only card we got that we didn't execute.

ALEXANDER

Well, we'll talk about this more when we get to X-6, but there's another point on that particular malf that I definitely want to bring up when we get there. Let's go on with the CV block.

MUSGRAVE

Anybody got any more on the . . .

CLARK

Do you want to talk about the X-4 on the aft flight deck? You might talk about the problem of the tape being loaded wrong again that you mentioned yesterday, about the follower . . .

MUSGRAVE

The tape going across the follower on the X-4, remember we had all that noise on the air; when we went to flutter compensation, it cured the problem. Sure enough, you guys picked it up and to see if we put the tape on right. And that was a matter of training simulation, we didn't have that high a fidelity. A training situation, you know how that thing was placed in there. Well, the seal, the forward seal to seal up the aft flight deck wasn't on there in the training. And when we approached that tape,

obviously we approached it from the side where we could see it and manipulate it. Instead of over the top where we couldn't get to it. That's one example of a training situation in which we never trained with the physical environment that we would get to in flight.

MICHAEL Chuck and Bob as experimenters did you feel that you paid more attention to your particular experiments?

SAWIN I was going to express that later. I'll let Bob do it now (laughter).

CLARK I became interested in all of them. I at least hope it didn't bias my time towards my own experiment.

SAWIN I guess I was the only one who had the real dilemma, literally, because Bob did not have to do anything in life sciences and really had to only tend to his payload. I had to - -

MUSGRAVE Bob gave tremendously to the life sciences effort.

SAWIN I know, but he didn't have a moral dilemma as to where he should spend his time. If he chose, he could go only X-21 and do that and we could never say "Hey, we need you here to do this."

MUSGRAVE It's still a moral dilemma, I think; you want to give the most to the mission.

CLARK The ground rules and the mission rules for our experiment were that X-21 for usage of my time should always take priority, over participation in the medical experiment. If we had had any major malfunctions that would have required more of my time, I would not have been able to participate in the medical experiments. It didn't work out that way. So I believe that I paid as much attention to the, was able to afford the time to . . . the medical experiments as much as . . .

SAWIN In my case, I'd say I chose to start up my experiment earlier because, first of all, we were ahead of time lines on day 1, we had a period called activation when we were to turn on various pieces of hardware, and we had a big pad in there so I was able to run some 8's and still do everything else with no impact. But I never had a problem if it got to a point that I should be doing another experiment but I wanted to do mine or some related to mine. And I think that I kind of got over the desire to overexercise mine in the first couple of days, and really

only went back to it then according to when the time line required that it be run. But it is a potential problem for someone who is terribly interested in his own experiment and not at all interested in someone else's, some other person's experiment. I didn't find it that bad a problem.

ALEXANDER Yet if you look at the cumulative runs (laughter).

MUSGRAVE Yes, but I bet they're no different than the last sim.

ALEXANDER Probably not.

MUSGRAVE You look at the number of extra 1-1's on the first sim and you'll see the same thing. Because it's so easy to run.

SAWIN Let me make another point. The time requirement to run a pulmonary function test is maybe 5 minutes if you're slow. So you can get the data and go on. You can do it between experiments, you can do it anytime you have 5 or 10 minutes. That just speaks for the type of data management system we have. The fact that it's something that can be done in a short period of time. Setup requirement for cardiovascular series is 90 percent of what your time allocation is because you have a lot more sensors to get in position; it takes more time. So, yes, I maybe performed it more but I didn't drag Story in or Bob in. I looked at the number of runs I have, I have three runs on Bob.

MUSGRAVE You'd save my time by running parallel. You'd have the system up and I'd just run over and get on the mouthpiece.

SAWIN I have 3 runs for a week on Bob's so I'm certainly not taxing his time there.

CLARK And it wasn't just because it didn't come up.

SAWIN No it was there all the time. It took us a while to settle into routine. Once we're in a routine, I didn't play with my own hardware that much. That's what it boiled down to.

MUSGRAVE Bob made other really significant contributions to life sciences doing other jobs which are not classically thought of as being done by the payload specialist. In other words, working on the waste management system. It's real funny. Cleaning up after me and cooking our - we knew it was going to happen because this is the team right here. The team of three and you go in there and we really maximized the mission. But it isn't classically thought of

that the payload specialist would be working malfs on the waste management system or cooking for the MS. I mean, this isn't what's in the books. But when you want to maximize the mission, again it's the same work. You take a mature team of guys that are working together and they know how to shift their time and shift their efforts and all like to maximize the mission. And he made tremendous contributions because he wasn't pushed quite as hard in terms of his time line as we were, to look after us and free us up from a lot of those housekeeping duties so that we could be back in the Spacelab getting with it. So he made a lot of contributions there. And related to the subject of flying a PI and is he going to give more preference to his own experiments, related to this is in the future we're going to pick the payload specialists that are super well known scientists within their own experimental area. And they will be very good, in particular life sciences, for your flying. We only flew 20 experiments this time; I imagine we'll fly 25 next time. So you've really got a lot of ground to cover. We're going to pick some payload specialists who are well-noted scientists within their area and yet their contributions to the mission will be running their experiment. They will be unable to run 16 or 18 hours a day which maximizes the mission. They will be uninterested in learning 19 or 20 other experiments, and they will be unable to run 18 hours a day on that number of experiments. We haven't exercised that yet. These guys are absolutely super as was Dennis Morrison on what it takes to maximize a mission. I think that's something to keep in mind in terms of what qualities you want in a payload specialist. And all these guys have certainly had it. While I'm on that topic, the general task required here, there was less biological art involved in this mission than the first one. In other words, the first one we had, we had animals that required tender loving care, sort of veterinary care. We had tissue cultures, we had sterile technique, we had a lot of microscopy. Fish eggs, tissue cultures, amoeba and this sort of thing, the plants. There was less biological art involved in this one. It was mostly bioengineering, bioinstrumentation, electronics, and data management. We had four PDP-8/E's, computer programs, really sophisticated equipment in terms of electronics. So I think in terms of future selection of mission specialists or the selection of payload specialists for specific missions, I think this is something in the future that that's an area, a guy needs to be pretty well versed in as opposed to biological art. There's always going to be some of that but this is real heavy in those areas. Of course, most of you, PI's and PE's, are well versed in this area.

CLARK

I'd like to comment a little further on the usage of my time on doing Orbiter functions, and cooking meals, and things like that. That's due to the nature of our experiment. The requirements that we had for our experiment was that I be able to spend 8 hours per day working full time on the experiment. Well, part of that is the nature of our experiment, we would set up a run to check a various set of detectors and accumulate 10, 20, 30 minutes data on that. And during that time, my time was available that I could go downstairs and cook up a meal or whatever. You have the same type of thing in many physical sciences payloads, where there is time available for that payload specialist even though he is dedicated primarily to one experiment. You take, for example, an astronomy experiment that you would have onboard. You have roughly 40-minute passes in which you can obtain data in astronomy; the rest of the time is available for that payload specialist to perform other functions if he's not analyzing data. So it's the type of thing . . . the entire mission approach of working in to get the maximum number . . . the total mission and not just dedicated to the one experiment. The other thing is on X-4, the aft flight deck; we talked about the tape-loading problem. In the Flight Plan, it was called out that Chuck or Story would put the X-4 sensors on me every night before they went to bed. Well, it turned out, with a slight amount of contortion, that I could put my own sensors on. And I did that in the middle of the night. I hope the data looks well on that anyway. But it is possible that you can get all those sensors on by yourself. It takes a very minimum amount of time. The problem associated with it was that, when you do that, you're moving around by yourself and you have to position yourself and sit down because you tend to pull those cables loose. Well, that's typically a one-g problem because you've got the cable support that's putting stress on those things. Another problem up there is when you get the cables on and you sit down for the 5-minute data run, is that when you sit down with the tilt of the scope which is up there on the Tandberg(?), you no longer can see it, so you can't really be sure that you are getting your scope display once you do sit down. . . . lift up a little bit and see if it's coming in and sit back down, again. So it's position of the display on that versus where you have to be positioned to be in a resting condition. That's all I got.

MUSGRAVE

Anymore on the cardiovascular? We covered a lot of other ground as well. Dash 6, Dr. Kimzey.

SPEAKER Steve's with the PI on the West Coast; Dr. Rogers is here today.

MUSGRAVE Went super. The add-on reticulocyte stain was fine. Have you looked at those?

ROGERS Yes, they look all right.

MUSGRAVE The whole thing went slickly. The training was outstanding. I got to do them for real in series a couple of times. Once on integrated sim day. And the human factors of laying out where the cages were and laying out, you know, where the bottles were and all the rest of that stuff; human factors was good, as was pointed out by Chuck yesterday. And when we really get to flying, we'll have a small animal enclosed environmental control system for small animals. I'd guess there's not much else because it really went well. Maybe the malf. We did run out of potatoes, like the day of - was it day 3 - I knew the ones that were going to be processed that afternoon, I took their potatoes away, they wouldn't need them (laughter). In fact, it yet, it might cause me fewer problems if they had less to eat (laughter). So I took those potatoes away and gave it to them - gave them to the last six. But we just, in the last day, before day 6, we did run out of potatoes, and I took food cans and saturated Kimwipe and put that in there for them. I guess the only thing, if you have any more, if you haven't looked at the data at all.

ROGERS The - All the tissue samples are in the process of being prepared with the exception of the blood slides; the smears we've stained those and need to take a look at them.

MUSGRAVE Some of them, they're okay, they are not super and I don't know what it is; it sounds weird but the reaction to the blood to the glass - there's a hydrophobic thing. Like you know sometimes you see water go like that; it zaps away from hydrophobic material.

ROGERS The reason for this which should have been done, and it was an error on our side. Some slides from the vendor are pre-cleaned, but some of them aren't, and they only look bad. The slides that you have, that you had, were not precleaned, that is, by us. You take a alcohol wipe something that you wipe off, and that problem goes away.

MUSGRAVE Some of them are all right, and some of them I'd zip like this you could see these little bubbles, these little clear areas where it was hydrophobic stuff on it.

ROGERS That's because there's a little film or there's a little something on there that keeps it from spreading.

MUSGRAVE I thought also some of them, I'd pull the slide back but the slide wasn't matching very well, and the line, it would come out just before . . . but I think they're all usable anyway.

ROGERS And, also we've looked at some of the reticulocyte slides, we haven't done the counts, we're processing the counts on those now.

MUSGRAVE TV helped a lot on that. It helped once when I hadn't done them for a long time, I guess a month or so. It helped - I was taking the stopper off and putting the blood in it, and I knew I was doing something strange and I looked at it, and I'm doing it but I couldn't figure out what was strange, you know. And sure enough he told me on TV, don't need to take the stopper off, just to check the blood. It helped a lot. It also helped on the reticulocyte thing to get that exactly 10 minutes. You all were doing the timing for me. You know I had a rat here and weighing, and this one going, and threes, fourths, stains going simultaneously. It really helped me to tell me the next stain that was coming up. The TV helped us there. I guess the philosophy, that malf - I discussed that malf . . .

ALEXANDER The only thing that really bothered us on the ground with the malf was the fact that we were not allowed to work the solution. It became obvious to us later on, in fact it didn't take too long to get very obvious, that the thing you wanted us to do on the ground was to come up with an alternate procedure for the euthanasia rather than coming up with a hardware fix.

MUSGRAVE The card I got I couldn't have fixed the hardware. My interpretation of that card was, that the vacuum chamber was failed and it wasn't going to get fixed.

ALEXANDER I guess we didn't get that. Of course, in the evolution of a SIMSUP problem the ground shouldn't have any information to go on except the thing has failed and you ought to muster everything you got available to you to fix it.

MUSGRAVE This points out something that we were getting the feedback - sometimes say 15 minutes after the malf, you all would know it was SIMSUP as opposed to - I think there was - there were other communications besides just laying the problem on and letting everyone flail with it.

ALEXANDER I think that's a good example of what you just said because as soon as we came up with a quick fix to get you back in business, which took about 10 to 15 minutes, they said, no, you can't do that.

MUSGRAVE They shouldn't have said that. They should have left a discrete card with me that says this is the problem and - this is the discrete problem. And so you know that when the ground is coming up with a fix, we have to institute the fix and see does it work. So we have to have the problem well defined.

CRESS I think the first fix we came up with was making the chamber . . .

ALEXANDER Well, Glenn, let me back up, that was the second thing we wanted to do. We wanted - The first thing we wanted to do was shut the mass spec valve off the vacuum line and verify vacuum integrity to the spacecraft. We were starting at square 1. We didn't know where to start. So we went all the way back to where we knew we had vacuum, and that's outside the mockup. We were told no, without any hesitation, that we couldn't jack around with the exterior valves - -

MUSGRAVE We told you the mass spec was all right.

ALEXANDER Yes, so we knew we had vacuum going down that line. All we wanted to do is kill that line, see that we had it back on the other arm of the "Y", which then it became obvious that if we have it at X-19 then we at least got it down the portside of the laboratory. Everytime we'd open one of those doors it'd be a blank wall. Eventually they said you can't go beyond that point, and that's when it became obvious we had a SIMSUP problem, not too long before that. The fix that we came up with, I think, still violated a mission rule in that we had to vent the cabin to space, even though it was vented through an eighth-inch line.

MANGOLD That's what I think. Why can't we vent to space? You can't lose that whole cabin through an eighth-inch hole. Those guys could pull that off and slap their thumb over it and that would stop it right there.

SAWIN You could let it leak all day.

MUSGRAVE If you had a hemostat you could clamp the line. They were Tygon lines.

ALEXANDER We had that, we had pliers, vise grips, channel locks, anything that could have done it, or a pencil.

MUSGRAVE Yes, well, the card I got you wouldn't have fixed it, and yet we were approaching the second group. The card I got says no matter what you do, it's going to be fixed (laughter). It will be fixed.

ALEXANDER Well, I just wanted that to get in the record. In fact, we liked to work the malfs; it was kind of something new, it got everybody sharp and on their toes and watching what was going on. When you work a good malf, then they said no that's against the rules.

MUSGRAVE I tell you that was a good one for us. It said it was not going to get fixed, and that was really grim.

SAWIN Do you want to discuss any alternate procedures?

ALEXANDER You pulled it off so well that we figured that you were using the vacuum system anyway.

MUSGRAVE No, we don't play the game that way. I don't, you know, we don't. If the thing says it failed, you know us, . . . we play it serious.

SPEAKER We thought maybe that black phone had found its way down to Flight and you guys had an understanding. According to the rules of the sim malf we weren't to be let in on it which would have been fine.

MUSGRAVE We never played that game. I think that's artificial to be doing something else on the telephone. You got to keep the team intact; that's a split between the team. We always communicated exactly. I think it needs - Introducing these malfs, you've really got to lay all the details down, otherwise the malf can be changing as you go, and that's - you can't even play that one, where you've got a migrating symptom. While I'm on it, it brings up a good example, the malf on 12 that they introduced. In other words, he said . . . a broken line between the electrodes, or something else like that, you know in the harness. So we said, well, the thing we'll introduce, and we'll make it very discrete is that there is a break at the connection, the pin connection, for the ground lead. We said that is our fix and we'll see how - that's our problem and we'll see how the ground handles it. They ended up changing out the harness and changing out the harness gives you a new connector and that cured the problem right there.

ALEXANDER That points out how good the SIMSUP exercises were, because that's the first time I knew that was a sim problem (laughter). I thought the thing that got stepped on in the walkthrough it finally let go. And that satisfied my own analysis of the problem, that it was a bad deal to begin with - -

MUSGRAVE The SIMSUP says you haven't connected up an electrode - -

ALEXANDER Well, he's a bad guy. He's bit me all through this mission.

MUSGRAVE That would have made it very simple, because we would have looked at the problem, that we would have cured it onboard. We'd have looked and seen it and said, well, the first thing you go and see if you connected all the electrodes. So we thought, hey, we got an exercise; let the ground get in on this one a little more. So - -

SAWIN I figured it was Story's turn to bite the bullet, so I said I'm the subject, you do whatever you want (laughter).

MUSGRAVE I did not connect the ground electrodes on the leg, but I said that is not the problem. And the TV was on so I didn't want any chance of you guys seeing that so I did cross them over like this and tape them so that they were connected physically but there was no electrical continuity. I said there is a problem in the connection to the pin the ground pin there.

ALEXANDER Okay, well, then you played it along that script then, because we asked you to verify that the electrodes were on. In fact, I think you even came back and said do you want us to use the meter?

MUSGRAVE Yes.

ALEXANDER But if you were going along with what you were just saying, you would have said yes, the electrodes are all right.

MUSGRAVE Yes, I would have.

ALEXANDER If you had to - you had to go along with the game at that point. Well, I think the PE's for 12 - and the PI's got on that one good too.

MUSGRAVE But Bill bought it, you know. He says - he bought it. He says, "the data's - we can live with it; we can filter that stuff out." Well, I didn't want to let him buy the bad,

you know. We wouldn't have - we wanted to pursue it further and I'm surprised - Is Bill here? Bill Crosier. He's saying go with it. Well, we only pursued it for a few minutes, you know, so I didn't want to go with that kind of data. So I pressed him, you know, don't like it, you got any other ideas. Well, change out the harness. Change out the harness would have fixed it, so we went.

ALEXANDER That was good.

MUSGRAVE Anything more on 6?

ALEXANDER Tom, you got any more questions?

ROGERS No.

SAWIN It's a two-man job, though, to make it go smoothly. When I was able to help Story and when Bob was able to help Story, it just went real well. If he has to do it all himself, if he has to get up from his work table go put some rats to bed come back and work on them one at a time - -

MUSGRAVE Breaks the continuity of the production line. But you guys were lucky on that malf. I was setting up for using the skeletal muscle apparatus, the treadle, you know, at 100-pound calibration weight. You know, on the head and it was that or the gig, and I didn't like either of them, but I was setting up for the treadle (laughter).

ALEXANDER Maybe it was your onboard mother that was really lucky that he didn't have to clean up the mess.

SPEAKER He didn't like that very much (laughter). So he kind of bent me around the other way.

SAWIN Suggested you try the noose approach. But then I said you're overdoing it, Story. He's sitting there (sound effects) (laughter) and the head about fell off.

CLARK There's nothing but a sliver of skin left holding the head up.

SAWIN "He's really dead, Story" (laughter).

MUSGRAVE But I'll tell you that was grim.

SAWIN He said, "I don't want him getting up on TV" (laughter).

MUSGRAVE Yes. I didn't want to do something and get him up on the table where everyone's watching me work and have the rat jump up and start floating around (laughter). That would have been really bad. So I was - but it turns out the neck was breaking just like that. So it was really humane and in terms of the science, it really got the job done. Really worked all right. When you came up, you wanted a TV documentary I said uh (laughter). I said you don't want that. Yes, we do. I said, no, you don't (laughter). Yes we do. You know it's really grim. Well we know, but we want it. And I said, God, it's got to work this time.

CLARK Chuck got sick over it all.

SAWIN And there was SIMSUP again, every time the door opened, it was bad news (laughter).

MUSGRAVE SIMSUP had him getting sick after the 9-C. But with a 9-C and doing that to the rats, the timing was outstanding.

SAWIN I had Story doing them right alongside of me so I could crack him and I guess everyone thought I got nauseated a couple of times.

ALEXANDER Well, you can thank Bunny for the realism there too, you know you'd just gotten away from your family call at that time, and she came back with a long look on her face and said, "Poor Chuck," and it was totally realistic that you flaked.

SAWIN So Mel asked her how was I doing. She said, "I heard he vomited" (laughter). She was in with ... SIMSUP. Everybody was in with SIMSUP.

ALEXANDER Well, it was they were all realistic.

SAWIN All I got were many curses, because all I had to do was eat and go to bed for the rest of the night. Story said, I'll trade with you (laughter).

ALEXANDER Yes, I think we'd better go on to 7 and 8.

MUSGRAVE Why don't you cover 7, 8, and 9?

SAWIN Okay. I'll cover 8. Okay. On 7, we had probably a combination of software and hardware problems; they were minor. Al can speak about data recovery. But I think these problems that we had sometimes delayed the onset

on the experiment run but they didn't often preclude acquisition of the data we needed.

MUSGRAVE

It's worthwhile saying that in training it wasn't until 10 days before going to run that the crew had an end-to-end run on 7, 8, or 9.

SAWIN

We were beset by PDP-8/E memory problems, and it wasn't until just prior to the onset of the integrated sim that we had that squared away. These problems were intermittent and were difficult to trace down, and we had the local representative for DEC out here on two occasions going through his rain dance, and still he really couldn't pin down every problem. I think there still is another possibility based on a shutdown occurrence there where we cut this intermittent power off of some of the gear when they had already turned off the whole system on Sunday. But there may have been some, perhaps, ac spikes or transients going through the system occasionally that would cause difficulty. But basically, we could have benefited from a little more time prior to test on 7 for each of us to learn the technique. I think that would have increased the data recovery. And I was supposedly the PI on this and I didn't know one of my options was that everytime I compressed the cardiac output button, I could get a cardiac output maneuver or I would have done it more frequently.

MUSGRAVE

Yes. We picked that up real time; we might as well do it every minute.

SAWIN

At least more frequently. That was a small communication problem with my own coworkers, but basically the run went smoothly and we got good data. On 8, it was a piece of cake; just really nice. Of course, I've had a little experience on that one, so has Story, and Bob was a super subject. Never blew a run. And everytime they bring him up and have him go through it, it went very nicely. 9, we had problems prior to test with the computer staying up for an hour at a time. I did a shutdown on it occasionally, but these two runs, there were no problems. The only problem - there were no computer problems. The only problem, one time we didn't make a hardcopy, but we recovered the data by hand logging.

MUSGRAVE

Probably you want to put in the program and see what the other one . . . you get an automatic hardcopy when you reach a certain stage. Yes. The 9's stuff, as long and big as they are, just went to - the computer just zipped right through it, so did we.

SAWIN

So I guess it's up to Mel and Jim and Paul. 16 falls in this same category, might as well hit it now.

MUSGRAVE

I've got a few other comments there on the practice in maneuvering. It's really nice to go in and practice it and watch the plot out, but I'm convinced that some of my cardiac outputs during exercise were lost due to not putting the right maneuver for the machine. And I learned that if you really slow down, for maximum inspiration to occur, really slow down on those first puffs and speed up towards the end so it won't trigger. And you really had to keep it going because the valve would seat, this valve. The Lloyd valve would seat occasionally on you and also you're afraid - you have to speed up more than in the lab, you couldn't go slow as you wanted to, especially from the middle expiration on down because that spirometer would trigger on you. You probably need a little more practice there. Just one other thing. In terms of our talking to that computer program, we started getting with it just the last week, but to start with we had absolutely no information as to where the program was going to lead us next. And I don't mean the whole program, because obviously that's a stack this big; I mean the crew-computer interface. We're going to see a lot of this in the future. That when you put in something, you're asking the computer to go somewhere, you got to know where it's going to take you beforehand. And we learned through training only that when you do this to it it's going to take you there. But even then you didn't know the criteria, you didn't have the little diagonal flow diagrams and all that told you where the computer was going next. And when it was asking you to do something, you didn't know exactly what your response had to be and what the tolerances were, and what would happen if you didn't do this or that. There were so many places you didn't have any way of regrouping. If you get into a 9-C that's an hour and a half total, if not 2 hours long, and if you got somewhere and you got hung at the end of the experiment, you could have been running on the bike for 50 minutes and lose it all because of just not hitting the space bar or some other kind of thing. We need more flexibility in the program, or maybe more smarts; maybe we just weren't smart enough. Probably if Don Mauldin was in there running it he'd have a way of regrouping it. So you need a way to get back into the thing and you also ought to have flow diagrams, something like the GSOP. Not for everything of course, but only for the - somewhat like the CMC in Apollo, where you'd know where the computer's taking you and you know what decision is used to go to which ever place you're going.

SAWIN

The problems here were related to the complexity of the hardware and the software. I think that the general agreement between Story and me is that, Bob's experiment aside, this was the most complex, integrated set of hardware onboard and therefore most likely to have problems. Don had a tremendous load to develop all that software, and things went along pretty well for a period of time, then we had these previously mentioned hardware problems that started eating him up because he couldn't be developing his programs when the machine wouldn't respond to him. That's a critical time there, perhaps the last 3 weeks prior to launch. He couldn't get in and put the final touches on these formats and programs because the hardware wouldn't react. So there were a lot of things involved that brought us right up to the line there before we were ready. And I guess it just says that if you're going to undertake such a complex set of experiments as that integrated through one computer, you're going to have to have a little more time to get it done. Besides which, the hardware itself is a piece of equipment that we've been - the PDP-8 - that we've been using for flight support since Apollo 15. It's in its fourth configuration and anyone who has dealt with computers knows they don't like to be remounted and moved like that and this one has been all over the world. So credit that the thing even runs. I feel we were a little lucky that we didn't have more trouble than we did. Basically, I think we recovered what we wanted.

MUSGRAVE

The PI's deserve an awful lot of credit for their support. They'd be in there running those things at 9 or 10 or 11 o'clock at night, Saturday and Sunday. They had the whole gang out there Rummel, Mal, Don, everybody. Everybody was there. But they deserve a lot of credit for their support.

ALEXANDER

Certainly a very dependable team.

BUDERER

I would like to sort of turn that and say that I think we got a 90 percent day recovery in spite of all the minor problems . . . And I think that's largely due to the crew's willingness to start over again if the computer failed early in the protocol or to do a few extra maneuvers . . .

MUSGRAVE

Did you correlate the time of day at all? I think that the cardiac output at night, considering the state that you were in by the time 8 or 9 o'clock rolled around, is

reasonable. I mean about - We were hitting a second, third or fourth wind about that time, and I tell you we were pushing.

BUDERER One of the things I was interested in, primarily, . . .

MUSGRAVE No, I don't think the valve was changing, I think you're just getting it slow as you can. You know you're running along the edge of the cliff, you're getting as slow as you can with the maneuver without going too far and letting it dump.

BUDERER . . . threshold of . . .

MUSGRAVE I don't think so; I don't think so.

SAWIN I had probably made that comment to you, Mel. Had the feeling that - subjective and theoretically it can't change, it's a software not hardware.

ALEXANDER What about the catheter? I never did really understand. We changed the - Did you guys change the catheter after the evening of day 1?

SAWIN Yes, when I got sick. The catheter happend to plug at that moment. It plugged because of my mucus secreting through . . . They were - -

MUSGRAVE Mucus, macaroni and chese, whatever (laughter).

SAWIN They were salivating. I guess they got excited each time they ran my experiment.

MUSGRAVE You didn't like to eat while I was on the mouthpiece. It was hard to stop in itself.

SAWIN So, the first fix that Story did was to swap the capillaries, to go to two 6-foot capillaries which - the ones we have on there normally are 10 feet in length. So when you go to a shorter capillary, you change the transit time through the capillary. The computation in the software is based upon a known transit time to keep phase relationships between volume and gas analysis throughout the tube. When you change that you got higher oxygen consumption rates, got some really squirrely-looking data that one night. So next day I took a 10-foot capillary and washed it. And by that I mean I took a GC syringe, pushed some of that standard cleansing agent, GSA, whatever it was - stuff off our pantry area through it, then some water. Flushed it with anything I could find to clear it.

MUSGRAVE . . . you started washing your mouth with soap before you got on that thing.

SAWIN Air-dried it, put it back on and checked it out, and we had no problems after that.

ALEXANDER But the 10-foot did stay on?

SAWIN Yes. The 6-foot was on only that one night. Pardon me?

ALEXANDER The 6-foot capillary was only on on day 1 in the evening.

SAWIN It wasn't day 1, it was day 3.

ALEXANDER Was it 3 when you . . . Yes, it was, it was the first X-6 day.

SAWIN When I got sick.

RUMMEL Story, I'd like to apologize a little bit about the black-box nature of the systems. You know we had planned to have a lot more downlink from the 8 system. Next go-round we will have that, so we'll have a lot more diagnostic capabilities as well as real-time data. We just didn't get the hardware in time.

SPEAKER Yes, this wasn't what was bothering me . . . just more information on the main computer.

SPEAKER I guess I addressed the in-flight support, but I also wanted to say a word about the training support on this one. Some PI's would let the techs do most of the training. Well, that works to a certain - it will get you to a certain level. But having the PI's there where you can ask him, and where he can be pointing out the little subtle things you're doing, affect the quality of the science and it's really important. It's good for crew motivation, but also they have a PI there, he can be even devising ways of increasing the mount of science you're going to get back. That was really important in these 7, 8, and 9's also, to have the PI's here at all training sessions. It helps to maximize the scientific return. Some of the technicians are really good in terms of the science also. But you can tend to lose some if you're not getting the feedback of what little things you may be doing that may be degrading the science.

ALEXANDER Is that it for those three? Lou has arranged to have coffee available in room 234 and we'll break for 5 or 10 minutes and then resume.

ALEXANDER

Okay, I think we've concluded 7, 8, and 9 and let's press on with 10.

SAWIN

Okay, first of all, I'd like to thank Mel and Jerry and everybody associated with it because they were always there. If we ever had a question, they offered an answer. I don't know how our data looks to them, but the support was always there. The hardware was terrific. The only problem we had was that day 1, walking in there I was tired and every switch was in the wrong position. It really tweaked me. So once we got over that hurdle, it was a piece of cake. And all I had to remember was to turn on the strip-chart recorder, which I occasionally forgot. The only other problem I'm really aware of is that one time, during an SAA late in the test, I chose to stop the FR-1300, stop the time-code generator and the strip chart, and go upstairs, do the SAA, and come back down and start them. I restarted the 1300 and the strip chart and didn't restart the time-code generator. But they could see it on the ground because they were looking at the record and playback on those channels and they caught it right away. From my point of view, it went real smoothly. The changes that were sent up to do the cupulogram on Bob Clark were very good with only one problem, which was obvious to me, and I cleared it with Mel, by resetting one switch that hadn't been called out. That test went extremely well, too. I think it was just polished and smooth and no problems. We had the pretest problems of picking up a real fine ECG, which we'd seen intermittently over in the lab during early training, and which was cured by putting a little insulation on the chair. Those are my impressions; I don't know what yours are.

RESCHKE

I didn't really have any more questions. I was more interested in how it went for you, persistent problems . . .
....

MUSGRAVE

These are good, those goggles work, and I learned - I learned. You have to practice. You lift them up so you get the seal, instead of pulling them way down here and you can go ahead lift them up and use that bridge in through here. You need to sit down and practice with them. You need to sit down in the chair by yourself and get them. And not only do you sit there, but you need to rotate because the light comes from different angles down there. Once you practice with them, they're really neat.

RESCHKE They really work pretty good?

MUSGRAVE Yes.

RESCHKE I'd watch you on the TV, you know, kind of moving around - -

MUSGRAVE Yes, but that's getting it right. You can't just slop them on there, you've got to put them on there right. Then you've got to rotate and get the angle from - the light is coming from different angles and then seal off every little thing. And it can be done.

SAWIN One thing that bothered me on the science side, because of my lack of understanding about the objectives of the science was the fact that, as I talked over with you a couple of times, my subject could literally turn on or turn off the response to a certain extent, that being ocular nystagmus and I didn't understand why you would want to have him enhance it voluntarily, rather than to try and not affect it, try and be a passive subject.

MUSGRAVE I think you're looking at the characteristics, and if it's there then you can see them.

RESCHKE The major parameters don't really change, it's just that you can completely shut it off if you have a passive subject . . .

SAWIN Okay, so the more the enhancement the better.

RESCHKE The better off you are.

SAWIN Now in running to Bob, I was concerned that - one time, too, I tried to run him during training - he had a little bit of a nervous flick in his eye occasionally and I thought that that would bother us. But it worked out beautifully because there was no baseline drift, and he went through that test just real sharply. We had no problems.

MUSGRAVE It was just - the experiment came on very, very early. The attention to detail's what did it. I think it was - What was it? A month and a half or 2 before we had baseline data and we had good procedures. About 2 months before going to run.

CLARK We walked in the first day and had good procedures . . .

MUSGRAVE

It was attention to detail and looking at what the task is and saying well I'm not going to touch anything up here, I'm not going to do anything unless I write it down. It's fantastic attention to detail that got everybody there that early.

SAWIN

The hardware was superb. Never had to recharge the battery on that amplifier and never had to tweak anything, except that one time when we had that ECG anomaly. Other than that, it was very nominal, which was good from the operator viewpoint.

MUSGRAVE

On the initial setup of controls and displays and all that, we got burned last time on the - on some of the gains and stuff on the first sim on the dogs, maybe on one other experiment. But I think even though we got away with it this time, it's nice - it's much faster to go in there because you've got so many controls and displays. But I think when we get to flying, I just can't believe that the crew will finish up at some integration facility, or even if it's down at the Cape, horizontal. I can't believe that between that point and going vertical and all the other things that are going to happen - I think when we get to flight for the first run on that, you're going to have to go over absolutely everything and verify your place. I just don't think we can rely upon that process. In all previous space programs, when you first got into orbit, you went through, and even if the switch, you're never going to touch it, the philosophy was go look at it, and put it or verify it's there. And so I think - I just don't believe we can go from that to this and launch and everything and rely upon everything being there. So even though we didn't play that game and we relied upon things being where we knew they always had been or should be. I think probably the next sim we ought to - the first time we hit that experiment we should go through a verification of everything is where it ought to be. I think we need some things like this to point that out.

CLARK

On the goggles. In training, we had considerable trouble with the goggles we used then. And the goggles we used this time I had no trouble with whatsoever and that's a real compliment to the goggles considering that they've got this nose to work with. The second thing was on the cupulogram that ran on Saturday, is the - there was some concern about the stability of the chair in the horizontal

axis. No problem with that whatsoever; the only thing I could feel was when I had my hands on the chair I could feel a slight rumbling of the chair. So by putting them on my knees, I felt no vibration whatsoever.

RESCHKE There was some concern about the chair being slightly off vertical . . .

SAWIN Well, in conclusion, it was nice to have you guys there and attentive and from, you know, from the operator point of view it really makes a difference in your attitude.

RESCHKE Well, I was sorry that I couldn't get back to Story with something more for trying for just generating spontaneous nystagmus.

SAWIN All he has to do is sit there, he'll do it.

ALEXANDER I've got a couple of things to say about 10. You can't say enough about the PI/PE team for this one because we dug Jerry Homick out of his garage with paint all over him one day. We drug both of the guys out at almost midnight to run the mod procedure. We also asked them to go back and do outside sound pressure level measurements around the mockup in the middle of the night. We also asked them to build procedures to do inside SPO measurements. These guys really came through. And what you said about them is certainly true and it's evidenced by the success of that experiment. One thing I'd say about you, Chuck, though, is that your understanding of those procedures, the depth at which you understood what you were doing, was obvious when you actually found a glitch in our procedure that we'd written on the ground to do the mod, to do the special run.

SAWIN One thing that bothered me is Bob was always working on the GDP, you know, just to find out if there was anything going on down there because he learned that there was a development file that he had access to, so he might give us an 8-hour-ahead look at what was coming tomorrow. He'd go up there and bang into that system and he handed me the procedures the night before and he said, "Here's what you're going to be doing tomorrow," so I had them all pasted in the book and annotated. Then I got a call the next morning that said those weren't approved.

MUSGRAVE

First call was they hadn't been set yet. Well, we got them but the problem there is I thought they'd been approved or they wouldn't have been in there. But looking at the way the GDP was set up, the procedures people were building up those files, the same files that we had access to. And if there ever is such a link available for up-linking procedures I recommend that the buildup of the procedures and the buildup of the things to be uplinked take place in a different file so we don't have access to them, and at the time that they're approved they would simply be transferred over to a file that we do have access to. Also in the first - when we lost the comm the first day, the first day or the second day - we lost communications before, about the same time we lost communications I was looking for shopping lists and found the thing that said that he lost communications. So we were able to do some work on getting that back.

ALEXANDER

I think using another file would take care of that problem. I think it's obvious - it should be obvious to you all what we were doing however. We had to take these things to the board the very next cycle of the board, 24 hours after we were building procedures and we did not then want to have to go put procedures in high gear and the checklist and FAO and turn them upsidedown to get you those things in time to use them. Especially, we took the cardiovascular stuff to the board while you were setting up to do them. So it worked out fine.

MUSGRAVE

Which points out something that the Science Manager ought to have the authority to change that kind of thing, I would think.

ALEXANDER

Well - I think that's possible.

SAWIN

What happened on that was we had run them and then we got one set of procedures and I looked at them and I said, Story, we didn't do it exactly like this. Then we got another set of procedures and I said, that's exactly what we've done. Because they'd been changed.

MUSGRAVE

I'm not sure we did it right, see, and if we had the PI in the loop real time he could have told us what he wanted and we could have done it for him. If we had him right there, and we didn't. I'm still not sure we got him the blood flows at exactly where he wanted it.

ALEXANDER

Well, as it turned out, you did. And you also enhanced the value of the special procedure by making your own suggestions to protocol and suggestions to measurements that you could take in addition to what the PI had come up with. I agree with you that there ought to be a better loop that you don't have to wait 24 hours to go to the board and try to get a special procedure or a mod to an existing procedure up to you. But we were playing this time very strictly by the rules that no one on the loop would be able to cut deals on the side with the crew to get additional information.

MUSGRAVE

Yes, but the Science Manager, Flight Director, and FAO, that's not on the side. That should be in line, and I think those people ought to have the authority to make those kind of mods.

ALEXANDER

Well, I think we could have pulled that off. That wouldn't have been too big a violation with Glenn and you in the loop.

SAWIN

I think this is the important philosophy in the future though as opposed to Skylab where anything was rigidly the same forever. You did it 59 days, now do it 84, and we all knew that in most cases things had plateaued and perhaps we could find out more information by changing protocols if not hardware. This was a very productive day for us. We felt really enthused about trying these suggestions. And so that may be where it's all going to come together as to the true value of Spacelab operations, when you have a team that can interact like that, you can get additional information once you've plateaued on the responses you were initially looking for.

ALEXANDER

Even though we were living with the rules that we had to use the board as a clearinghouse for doing things like that, I would say in support of the board that those guys really were always there and always willing to do everything they could to maximize the yield from the mission. We've gone over our problems with the conservative approach that safety took in the test; that doesn't need to be beat back anymore, but the board was there, they were there on Saturday morning and, had we had a board meeting on Sunday morning, I think they would have been out there for that too. There was a lot of interest shown by people on the board. The last comment I have about 10 is it just fell

through the crack. We ran into the red goggle problem in reading CRT's before. We saw that in Huntsville this summer and it should have been passed on, but now that it's happened it's an obvious thing that it does filter out the green - phosphor.

MUSGRAVE It's no surprise; it happened on the first sim too.

ALEXANDER So it's just something we've got to keep in mind that we can't really expect the dark-adapting crewman to go do a lot of productive things where he has to read phosphorous and what-have-you.

MUSGRAVE A couple more amusing incidents. The first one, I'm supposedly flushing the catheters on the dogs. Pulling back and pulling back, looking for blood. And Dennis is looking at me. He says, "what are you waiting for." I got a syringe full of blood. I couldn't see with the red goggles. The other one was the chromatograph used red ink on the first one. All these peaks are coming off and I'm reporting there isn't anything there. But it does diminish, not only in what you can see, it gives you a disorientation, the red goggles do. You just - you're not yourself entirely. I don't know if you've got an explanation for it but it's true.

ALEXANDER Well, you ought to ding your depth perception pretty good as you dilate.

MUSGRAVE Obviously, the eye is more than a camera. You've got an integration process back here and it's seeing different things. It does give you a slight disorientation.

HOMICK Mil and I have a couple of quick questions. Were we the only experiment that had an onboard strip-chart recorder?

MUSGRAVE No, there were a bunch of others and thank goodness this time we had the takeup reels.

HOMICK Okay, and did you find, in our case, the strip-chart recorder to be a valuable tool in terms of . . .?

SAWIN Oh, sure. How else could you follow the nystagmus? On a scope, it wouldn't be very meaningful. Maybe on a storage scope, but it's too fast a response. I think you need it on a strip chart.

MUSGRAVE The chromatograph and the echo were the only other two and the echo really isn't a strip chart; it's a pictorial, a picture. So the chromatograph is the only other . . .

SAWIN I think it's - although it's big, it's required. Particularly, if you had a problem, you could go back and review the whole run. Like one time when we got four cycles when we should have gotten five. I don't know what happened, the switches were in the right position . . .

HOMICK Chuck, what about the layout of the console? It appeared that you had to stoop down to use the strip-chart recorder.

SAWIN It would have been nicer. Just like on X-14, on Mary's and Dick's, if that CRT monitor had not been mounted up overhead, rather, but alongside the scope. Or if you could see the same things going downlink when you were looking through the scope, any of a number of things human factor-wise might have been nicer. Well, I don't know, Glenn. It's a distance between a floor, or a top, ceiling, or whatever, and that it should be somewhere in the middle. And it's down there, I had to sit on the floor or be on my knees. Of course, I was also conscious of your trying to view the subject through a camera. Sometimes it was the forward camera looking through me at Story. So, I'd occasionally look over at the monitor and see that I was standing right between the subject and you so I'd get down out of the way. I didn't have to but I did.

MUSGRAVE In Spacelab, you may keep a one-g orientation, even in flight. Like, you know, the workshop in Skylab, you train for years and years in one g and they kind of treated that like one g. When they got into space, they did things about the same way. Yes, but when you go into the MDA, which every time we trained in that we have a different rotation according to what you had to do, it really screwed you up. And in flight there was no up or down in that thing. And in the Spacelab with all the training in one-g, I imagine you'll probably put the foot restraints at the bottom of the run on the rails and probably treat that as up and down.

SAWIN I think anything that requires monitoring should be at either a sitting or at eye level relative to your normal reference.

HOMICK Bob, did you have any trouble with the portable sound level meter or with procedures we sent up?

CLARK No. None whatsoever. It's a good instrument, and we whipped through it and it took I imagine an hour or something like that to get all the measurements.

HOMICK One thing that I didn't check with the procedures people yet, but I have the data. The locations apparently are by a number and I'm assuming that there must be a little key somewhere that indicates where the locations were.

CLARK Yes.

HOMICK I guess I didn't get the entire package.

DELUCA There's another section. I thought I put the whole package together. I've got a copy in there and I'll give you one.

CLARK There was a list of each location. I added one location in there, I believe. It was a measurement with the oven open. And all the other ones were by the list that was provided in the procedures. The one thing I pointed out yesterday, is, if we're looking realistically at what noise levels might be like in there, is those probably ought to be rerun with the carpet out of the mid-deck because the time we did the dry run, after that time they put the carpet in, we could - at least I could perceive a difference in the sound level in there because of the carpet being in the mid-deck.

CRESS The original still should be onboard.

HOMICK Well, I have a copy of . . .

ALEXANDER Lou just went to get you one and the Data Manager now has logged a complete set of data and procedures so you can get it out of that system too. We better go on with 11 if you guys are wrapped up.

CLARK One other thing that was brought up was the noise of the strip chart, and that you could hear it when you were in the chair. Was that any particular effect to your data?

ALEXANDER Yes, it was the timer. The time code . . .

RESCHE

That can cause an orientation problem. Story is an excellent subject for this sort of thing because he seems to be able to ignore a lot of the distracting influences.

MUSGRAVE

It's just them doors banging with the wind. That didn't bother either. But it was interesting, have them rattling out there wondering if the wind was blowing. That was about the only input - that came up yesterday. We were really totally isolated in there and you know it felt like a spacecraft. If nothing else, even if you heard it, it didn't do anything, you know. It's just like that. But the doors rattling out there, you know, you could really hear them.

CLARK

The procedure for the cupulogram seemed to be less sensitive to subject concentration than the regular procedure. That was an enjoyable ride.

MUSGRAVE

Eleven went outstanding, Larry and Carolyn, without a hitch. It was good from the beginning. Of course, I had plenty of experience with the first sim. Human factors was excellent, procedures was excellent, plenty of systems training, malfunction training, got plenty of that. I was really qualified to inject the dyes and follow the circulation and change out electrodes, or any other darn thing. That was one of the few onboard schematics we had of the system that a malf could occur and I could tackle it myself. So the whole thing went slick. The blood drawing went really slick and human factors was really good. Don't have an awful lot to cover. The dynamic loading, the additional glucose run, the dynamic loading. At least to the eye it went very well. The final glucose load, the final one we run after the dynamic loading, I got a feeling that my pipetting didn't go so good the last - I don't know why, the last bunch in there. Now the pipetting - I just don't think that those things are designed for wiping the drops off the outside. Now it depends upon the material. Serum, nothing. There's no serum sticks on the outside. It depends upon the substance that you are pipetting. On some pipettes, the water - boy, it will hang on there and make a big, big, blob, and which reminds - keys me to bring up the only suggestion I got on the hardware, and that is the cover plate you put on there to get the numbers. That when you put the pipette in, and it may have happened to you, I tried to go right down the center so I'm not touching the cover plate or the side of the reel rotor. But as I'm

pulling the pipette up, it depends upon the hydrophilic/phobic forces between the pipette and the liquid that's down there, there's times, it lifts that up, and if you ever touch the edge of - and especially that fine line with capillary tension between the cover plate when it's really tight and the rotor, that fluid runs down in between there. And that happened to me on that last glucose, so there was nothing I could do. I mean, I could see it on a whole bunch of loads there, that I had fluid running down in between the rotor and the cover plate, and it really bothered me but there wasn't a darn thing I could do about it. When you're pulling that up, if that water - that fluid that down in there hangs onto the pipette, you just can't hardly load it without touching the sides as you pull that thing up there. So I think maybe that would be part of the problem. You might try just labeling the rotor itself but that's no problem, so you avoid putting that cover plate on there. And at least then you don't have that fine line with all that capillary attraction where the fluid can zip down in between. In terms of hardware, I guess that's about the only suggestion I've got. Of course, you'll eventually need to work out the zero-g blood-handling techniques or whatever, but that's within the state of the art. So the whole thing really went slick, though.

LEACH It went slick from our standpoint and you did a very good job. I know having the urine system down we had to jack around with the procedures . . .

MUSGRAVE We ran urines on them. Oh, you mean on the GO? Yes, we ran urines through the APS last time.

LEACH . . .

MUSGRAVE I don't mind wiping the tips, I'm just thinking, I don't think the instrument was designed to have you do that, was it?

LEACH . . .

MUSGRAVE Yes, yes, that's true. They were, yes. And the serum, the serum doesn't hang onto it and I'm sure. Well, you guys know much more about that than I do, but I'm sure you can design a plastic or something for giving substance, you can have the right properties. It's dangerous in wiping the tip off. There are times I'd be wiping and I'd say, my God, did I touch the end? I mean, I can't see on

the tip where is 10 but if I had any question I'd throw that away and go do it again. . . . nice peaks. It's come a long ways since the old card data system, too. It's really outstanding and fantastic support all the way around.

SAWIN Only one small problem on the first day which was day 2, somehow a few test tubes were mislabeled, but that's a real minor problem; it doesn't have anything to do with the hardware or procedures, just - -

MUSGRAVE That was during integrated sims.

MUSGRAVE Yes, it wasn't during flight. I just scratched them out and put them on.

LEACH You're saying that was one reservation. I don't know how you feel about it but you noticed a definite learning curve, improvement, or what-have-you even as you'd done before you went in there. . . . The first day, the amount of time, the second day went way down. And I think on some future sim that we would do - I would like - the PI requested a couple of training sessions with the lab cleared and us talking over a comm loop . . .

MUSGRAVE It's really critical when you get the old production line set up, if you've got a break, if it comes at the wrong time, did I fill that one or didn't I fill it, and there's no way to look in most of them. So I developed a way of drawing a line on the tapes so everytime I'd fill it I'd rotate the thing so the next one on the line - but you know it depends on when the interruption comes.

SPEAKER I'm sure you're aware how much you decreased the time the last time you ran . . .

MUSGRAVE One other thing, I know we already discussed it. Get a pipette where you don't have double or triple water. You get the one pipette that's got the right amount and that decreases your time.

SAWIN And this is an FAO impact on running the 11's that I had a lot of free time and I know there weren't that many things in our set of experiments that I could have been doing, but in the future when one person is going to be tied up for a long period of time like running the 11 series say, 3 hours or so take a real hard look then at what that other crewman might be doing to be productive. Now I found things to do.

MUSGRAVE He did. He'd be setting up the cardiovascular, cranking it up and getting all the sensors out.

SAWIN And cleaning Story's dishes or something.

MUSGRAVE Now the other cure would have been to have trained in parallel somewhat were - although I think for that experiment, it's nice to have one person doing all the loads. You get a consistence on the rotors. And it isn't like he could be handling the blood because it's a serial operation. You need to centrifuge, you need the, you know, rim the plots and skin it off and do all those other things in serial. It does point out that Chuck did not have a lot of solo work that he did. I had a bunch of solo work, and he didn't have a lot of solo work. In other words, experiments that he ran by himself. But he did fill in the gap by cleaning up - those time buffers we spoke of before. Setting up things for tests to run in the next one, cleaning up and all that stuff.

SAWIN Another vote in for the butterflys. Other than I almost pulled one out of Story's arm when I went to hook up the syringe. Had it in about that far, and I had it out of the vein, but not out of the arm.

MUSGRAVE I was hanging on the butterfly.

ALEXANDER I wonder what impact an X15 - would have had on you because you'd have had to use the same venapuncture . . .

MUSGRAVE We planned it that way. That's why we did the 15A's on 2 and 4; we had enough material left to do it on 5 also. Bob will discuss that.

ALEXANDER Just as a point of prediction. I know you can't really because it never happened to you, but once you made the venapuncture, would you have been willing to allow either PS 1 or PS 2 to make injections - forget about the isotope committee for a moment. But would that have been a viable alternative - -

MUSGRAVE Yes. But it was no problem setting up and doing that myself, you're just sitting there with it. You get the isotopes sitting in the lines; it's just a matter of shoving on the syringe. But yes, it would have been all right. We'd have left the butterfly in for that. Of course, it wouldn't behave used this vein; use a vein down

here. So you take the butterfly and just like on IV right down here, instead of here, because you can't be doing this and going around working. Put the butterfly in down here somewhere.

MUSGRAVE Yes. Well, flush it with saline, heparinized saline.

SAWIN We could have done another stick in the other arm. It didn't matter.

SAWIN I don't even like it and it's still easy. Well, you know, the syringes were a little grim, though. When you're trying to fill the 60-cc plasma syringes with a 20-gage needle jabbed in your arm an inch and half long and you're watching your vein hop up and down. Guys fighting to draw . . . syringe. It's just a little grim. It's much nicer with that butterfly.

CLARK I think you're going to need two sticks for the cardiac output anyway. Their preference was to do the injection in one arm and do the blood drawing in the other. So therefore, one of those would have been coupled in with the X-5 experiment.

SAWIN I've been a subject for that previously and . . . We did those on the recoveries of the Skylab and ASTP and I was a control there and it was nothing. Another stick doesn't bother you at that point.

MUSGRAVE Thanks a bunch.

LEACH . . .

SAWIN That GO analyzer was just super. Potential piece of hardware . . . Really amazing.

MUSGRAVE That brings up a point I hadn't mentioned before and that is, you all put out a tremendous amount of effort and time to participate in these simulations. Hopefully, if you get something out of it, in terms of getting something flight ready and you identify problems of getting operational. And maybe Bob, when he gets to 21, he can address what some contributions that the simulations made toward getting up some flight readiness. I really - I can't help but think that it contributes an awful lot in getting up to flight readiness. I've seen it on this one - It was in really good shape for the first one, but the second one,

you know, was just a breeze, it's all there. Same with the vestibular one, you can just see it. After one of these things, it comes in like a breeze, it's there for the next time around.

SPEAKER

. . . .

MUSGRAVE

That's a reflex of mine when I throw two different things together to do this with.

LEACH

. . . .

MUSGRAVE

I had to keep myself - not to do that to the centrifuge samples.

SAWIN

I don't think just anybody can run that device.

LEACH

Sure they can, some better than others.

SAWIN

Because you saw, well, of course, you had the same background, the same - you've done - -

MUSGRAVE

The rotors take tender loving care.

SAWIN

It takes a guy with a lot of patience and care to do that right.

SPEAKER

But the nice thing about it is, if he goofs up, we see it.

MUSGRAVE

You do? Well, you see it on the oscilloscope. The oscilloscope is really nice. The reward is there or vice versa.

LEACH

I realize that the data system with it coming out on the teletype wasn't the best

MUSGRAVE

It would have been fine with us to have it inside. But you may want to go to a CRT display.

SAWIN

Story's pointed out one impact on our time lines was that these things were being passed back in - it was more so early in the mission than later - They were being passed back in and then Story would have to sit down and evaluate them - the teletype reports. And then talk it down to Larry or you. And this was never accounted for in what time we were allotted for doing that experiment. Now as things went smoother or we were more confident, however, - -

MUSGRAVE You had to do that the same as the 7, 8 and 9, so -

SPEAKER The next generation . . .

SAWIN I just said Larry was there almost as long - as much as we were. He was there when we walked out Sunday and I thought he stayed the whole week.

LEACH The deal about the TV coverage while you were working on it Larry was jotting down things to tell you . . . I think that's very good.

MUSGRAVE There's a lot of things coming on this support TV.

ALEXANDER X12.

SAWIN Okay, it started way back in the back and came up real fast. Earl responded superbly to our requests and suggestions and - -

MUSGRAVE It was ahead . . .

SAWIN Well, initially, though, when we sat down with it it was, what are we doing, and then the second time it was just real good and, after that, it was superb. The attention to detail, as Story said, was wonderful.

MUSGRAVE In terms of getting there on time, it was way ahead. We had three baseline runs - we had two baseline runs the day before we got to integrated sims. In terms of hardware procedures, it was real - it was early. And the one reason was that we were training on it during Christmas week. Most people didn't want to train then, but we got in there and as soon as we got in the integration facility not the Spacelab, we were doing runs. The experiments - we were doing runs in the integration facility and kind of got ahead. That was true of that one. And the procedures are real good. And the human factors are real good.

SAWIN Except for the chair itself physically . . .

MUSGRAVE The chair was eating our lunch in one g because it was heavy, and dragging it across the carpet and the carpet wasn't attached, it would roll up underneath the chair. The other guy couldn't help because he was all wired and couldn't get far enough away to help you. That's a one-g-peculiar thing, zero g would do this way. So, we did have

the one malfunction we discussed already. And the connections on the back there took a beating because of moving the chair around and brushing against it, and maybe that's something you would want to put - you would want connections, which really attach on and maybe some protection to those connectors back there.

SAWIN

I have two thoughts on the force amplifier. I think we'd have probably not had to calibrate that device, if those had lock knobs or something. Because each time we would move the chair, invariably we'd push against one of them. But the electronics were very stable and they were - -

ALEXANDER

I think you've got to hard-mount your simpson in some way where you can see it and not have to bang around and run the risk of dropping it again.

MUSGRAVE

Well, the whole turret fell off that time, you know. I was dragging the chair, or one of us was, and the whole thing slid off the arm and fell over. I don't know how it did it but it bent the plate behind the needle, the indicator plate. So what we did was take the glass off and bend the needle out so the needle wouldn't hang up on the plate. It looked like a good reading and you all liked it, too. They all came off without a hitch though. It was really nice.

SAWIN

I'll tell you, you really taxed us on Saturday, the 60 percenter for 2 minutes was the limit, the absolute limit.

LAFFEYERS

That's one of the questions I want to ask you. I've got a number of questions I'd like to ask - but before that I'd just like to just reiterate the fact that you all did an excellent job, we felt, on the experiments. But again based on our training runs and the baseline runs we got and so forth, I was real confident when you went in there that you would have no problems so that was borne out. We had the one minor glitch on day 1 that couldn't figure out for awhile, and I think on that one we recommended, finally, your changing out the harness. And if you'll remember, you checked the harness connection to the top of the EMG system and found it was loose at that particular time.

SAWIN

It had strain on it. One other point that I have, is a small point, goes back on the 21st of January. I had a note here that said, "X-12 no force recal required between

back-to-back subjects." And A-1 we got jumped real good for not doing that. And it was a misunderstanding because I don't think you were present at this debriefing we had, which was after one of our wet runs or dry runs.

MUSGRAVE It wasn't a jump. Again these procedures are there, it's a common agreement as to how you're going to run things. And they're in there, and the ground didn't see it and they're just letting us know that, "Hey, did you forget that or something?"

LAFEVERS It was just a misunderstanding, I think.

SAWIN We put it in there after that.

MUSGRAVE That's what procedures are there for and we put it in.

LAFEVERS We determined later that we could look at it on the strip chart. And, you know, and if it looked like it was all right anyway, we would just have you run the thing afterwards, but I think - Well, we didn't have you run it again so it looked pretty good.

SAWIN After that, we just put it on.

MUSGRAVE It was a one-g thing. The guy's strapped in the chair and is trying to put that treadle in and hold it and line up the holes down there.

ALEXANDER I read from the log that at 03:18 on day 6, GMT, MS commented on the 60-second, 60 percent MVC it's in quotes "Jesus Christ! Who thought that one up? The PI or the SIMSUP?" (Laughter).

MUSGRAVE He was keying while I was talking. (Laughter and chatter) Who put that on? The PI or SIMSUP?

SAWIN You know I'd gone through that first, and I said, "Story, this is really close. This is hard."

MUSGRAVE But I didn't believe him. I didn't think 60 and I pushed on it, ran it up there and in the first 5 seconds I said, "My God" (laughter).

ALEXANDER We know now why you were so accurate in gaging how much foot pressure you had put on the wet trash locker (laughter). Because the numbers were the same.

MUSGRAVE That was the ball and the heel and everything, the whole leg down in there.

ALEXANDER Earl, I think you guys did a good job. And I'd say that they were certainly there when we needed them. They had some travel times to work out.

SAWIN Clete and Earl both responded real well to any problems we had.

ALEXANDER Some people live, you know, more than just across the street from the center and have some logistics problems in getting in when the flight plan is being played real time. These guys were always leaving numbers and they were there.

MUSGRAVE The phone patch would have fixed that.

SPEAKER Yes.

MUSGRAVE With you guys there to look at the data and be telling him what the data shows and him there to give the interpretation and the advice, the phone patch would have fixed a lot of that logistics.

ALEXANDER We almost fitted Dr. Reschke with one of these wireless mikes that the refs use, though, because he had two soccer matches during the sim, and we couldn't get him off the field. Now these guys were always there, and again they live in Friendswood and it's hard to get them out. Usually, by the time we say we're going to call them and give you 30 minutes notice, you guys were into calls or something, and they always busted a gut to get over there. That goes for everybody, though.

MUSGRAVE This thing - My mind rambles on here. This experiment points out - We ought to develop a temporary way of marking electrode sites. In other words, there should be something between nothing and a permanent tatoo, you know, when that thing was distinguishable to the naked eye. There should be a temporary - I don't know whether some kind of a dye, a food dye.

MUSGRAVE There should be something between that you - that really enhances the sites. Something that you can redo every week or so. And what we used on this - our idea on this one was to shave the hair, so you put the electrode right

in where you'd shaved the hair, you know. We got all these guys here. That kind of marks the spot pretty good for it.

SPEAKER You mean you just look for the abrasions?

MUSGRAVE For him you just look for the welts you put it on the explorations.

MANGOLD What about gentian violet?

MUSGRAVE Yes, I don't know what would do. But I think someone in LSD ought to work on that because there's so many applications. We had a total of what - about 24 electrode sites where we were trying to put electrode to the ninth series, or VCG, or EMG. We got about 24 electrode sites that we could have used a mark on. They were dependant upon having it in the right position for consistency.

ALEXANDER I like the idea with you guys, though, that you had the foresight to stow electrodes onboard for the entire run and it was just a pass out. We didn't have to clean them. And this isn't a big deal, we've certainly got people and time and all that to clean up electrodes when you shoot them out. But it's nice to know that those guys are loaded, you've got an extra run, they've got an extra set onboard, I like to see that happen.

MUSGRAVE For a 7-day mission, I think that, if it buys you a total of an hour's time over a week period, it's worth it.

ALEXANDER And I think it was equally nice for you all to be able to throw your electrodes in 99 and go on without having to jack around cleaning and repasting.

SAWIN It would have been tough if we'd had to fool around with them each day. As Story pointed out, we had 10 for the X-12; we had 8 for the cardiovascular series, and we had 3 for the vestibular, that was almost daily. Then we had to redo the ones on the thermal sensors, another eight. That we had to do.

ALEXANDER That's a luxury we can't expect in flight, but we never really wanted to bother PS2 on whether or not he got his Orbiter X-4 in the middle of the night. And there were cases where that didn't appear in the log, because you might have done it and didn't mention it or it got overlooked, but if you've always got a dirty sack of electrodes out for PS2 we'd know it was X-4 in the Orbiter. It was always done. It was always called down.

CRESS When I was on at night, we always called it out and I logged it and assume everyone else did the same.

MUSGRAVE Like I think we kept it totally where we were and where we were going.

ALEXANDER Oh, you bet.

LAFEVERS I have a couple of questions now for you. The little electrode packages we put on, we put everything in one package. Do you agree that this is a good way to go if we have these types of electrode packages?

MUSGRAVE Fine.

LAFEVERS Also, I would imagine that you would recommend disposable electrodes?

MUSGRAVE Ones that we can put them back in the bag and bring them home? Same thing.

SAWIN It's just that we wouldn't want to have to clean them, that's all. And if you don't clean those, they spoil, right? Because they oxidize.

LAFEVERS That's what I'm afraid of. Now we are embarking on a little program to develop disposable electrodes. One you just use and throw them away.

MUSGRAVE Can you develop something you stuff them in - -

SAWIN Cleaning solution you stick them in.

MUSGRAVE Cleaning solution. You just stick them in and just seal the bag or something.

ALEXANDER Some kind of neutralizing solution.

MUSGRAVE Looking at the cost of space flight time, probably if that saves you an hour on a 7-day mission, it's worthwhile to throw them away even if they're not throwaways.

SPEAKER You'd miss 3 or 4 meals if you had to clean all of those electrodes.

ALEXANDER Well, we bought that recommendation really big; I think that was good on the part of the crew to suggest that we do it on the ground and I think it worked well.

MANGOLD Aren't there satisfactory dry electrodes available?

SAWIN Dr. Hoffler's working on some.

LAFEVERS We could probably use flush-type electrodes, where you just wipe some solution on the electrode and the electrode is flat against the skin. That seems to work pretty well.

SAWIN You know, still you've got 10 stomaseals to take off, you've got to clean the electrodes, put on new stomaseals, you don't cut that much time. I'd say you ought to try to go with the philosophy that cost of those can't be so high, that it really impacts the mission.

LAFEVERS Yes, I agree.

SAWIN They should be there prepared pack by pack, day by day, what you need.

LAFEVERS The meter position now on the chair itself, did you have trouble with that? Would you - do you have any recommendations on whether the portable-type meter is the way to go? Or should it be on the chair stationary? Do you have to move the position of the meter around for you to view it?

MUSGRAVE I think it was fine, Earl.

LAFEVERS Just that way it was?

SAWIN That Velcro approach worked well once you got the Velcro to stick.

MUSGRAVE Some times might come up when you'd want to read the meter somewhere else, depending on who was reading it. I think it was fine.

SAWIN Since we used both left and right limbs, you had to be able to move a little bit. You needed some rotation to . . .

LAFEVERS Okay, changing out the electrodes. We're changing them from leg to the arm. Now we, for example, we had two harnesses aboard, one we used a spare. When we originally had thought that if we would provide two harnesses and

probably a spare beyond that. But the two harnesses would be for - one harness would be hooked to the arm and the other harness to the leg and that way all you'd have to do would be to change the harnesses at the plug level.

SAWIN I think it would lead to more confusion and error due to the extra umbilicals.

MUSGRAVE The way it was was good. And I don't think you could rely on hooking them both up and going through the physical change of, you know, switching the machine over to the arm from leg. If we got caught once or twice. That - There was enough movement that you could unplug an electrode. So I think even if you had two, you really have to pay attention to when you got done all the moving around and flailing around, reconfiguring, that you've really got to look to be sure that you're still hooked up. You caught us once on the ground.

SAWIN That's another point, Earl, that it would be nice to have some padding on that chair on the back, because you have your VCG electrodes on, and you're doing one of these max contractions you're planting that M electrode in your back because there's nothing there to take the stress off. Some sort of simple foam padding. It doesn't have to be very thick, just so you're not hard up against metal, when you strap in with the strap.

MUSGRAVE It's a nit-picker, but the belt across here, of course - When you're doing a cardiovascular one, it was right on top of the phono, so we didn't use it, but the other thing is put a little foam on it because when you - the bare skin and the cold buckle, you know, it really grabs you. It changed the physiology, you know.

LAFEVERS In your estimation in running this, do you feel that the shoulder harness - I know that you have to have the lap harness, but the shoulder harness, did you feel that this held you in better position than not? I think Chuck . . .

MUSGRAVE I liked to use it myself.

LAFEVERS - - especially in zero g, it would probably be advantageous to hold you in place.

MUSGRAVE

For Chuck, on your experiment, of course, the shoulder harness fixed his shoulder but he was using the left one. So it would be different for him than for myself. I liked to really cinch both of them down, I pulled them up really snug on those.

SAWIN

It depended a little bit on the stress level, too. When we got to those higher levels, I felt the need for being further restrained. But on the low levels, for instance, when we did one of those X-2 mods on Saturday, we had to take one support plate that might support the forearm off in order to put the arm cuff - arm band on. And in that instance, you had only the elbow as a support and it's really no problem. So, it depends on - I'd say if you're below 50 percent of your MVC, you don't need to worry much about the shoulder strap or support for the forearm. But if you're getting up to the 60 percent area, it's real tough. It starts hurting. And then you need everything you've got.

LAFEVERS

One of the reasons for using that, of course, was to keep the position fairly constant. And as you say, when you go to MVC or higher level - percentage MVC, there may be a tendency to change the body around and then you can bring in other muscle groups you know, which may have an effect.

SAWIN

They're being used anyway because I have a sore trapezoid or trapezius or something in that shoulder girdle area that just hurt like hell for a couple of days after I do those. You can never, I don't believe, I don't think you can ever totally isolate all other muscle groups from the total system.

LAFEVERS

You just hold there.

SAWIN

Yes, I agree with you, the more restraint, the better, because at least it keeps the configuration the same between tests.

MUSGRAVE

Did you ever think of adding some quantitative warmup contractions before those MVC's? There was - I know you got to get to the same place when you're doing that collective data, but did you ever think of having - even nondata collections - you know, a few to 20, 30, 40 percent, whatever, before those MVC's because we're coming in cold and we sure saw it out there in the integration facility. That brings

up another point, where you're going to collect baseline data in the integration facility's got to meet physiological conditions. It was colder than hell out there those days. When we were training out there - and our MVC's were way down because we were cold, you know, we were shivering. And the MVC that's the first maneuver we did, and you can't expect a muscle, when you're shivering and cold, the first time you ask it to do something to come up to an MVC.

LAFEVERS Either that, or we'll have to move the MVC to a different location.

MUSGRAVE Or put it on the end of the protocol.

LAFEVERS Or right before the fatigue session, something like that.

MUSGRAVE Yes, in fact, that would be a nice place for it, after the 10-second runs to have the MVC and then the fatigue session.

SAWIN You were impacted somewhat by our daily rigor, though, because there were times when - I'd say it was the second series of runs, off the top of my head. Both Story and I noticed the decreased the MVC's and we were tired.

MUSGRAVE Oh yes, the data on all the experiments - the experiments were sensitive enough, so that the data from morning to 9, 10, 11 o'clock at night, really changed. You were a different subject.

LAFEVERS One question I had. You run this experiment 4 days in a row for relatively short periods of time, but we had a fairly good percentage MVC on it, at least on the 1-1/2 to 2 minutes. Subjectively did you feel that your isometric capability increased any as you held that load, say the minute or 2 minutes?

MUSGRAVE You mean when the fourth day versus first, did we have training, training effect?

LAFEVERS Yes. For example, did you feel that the muscles - that you developed a little bit more capability in that muscle as the day proceeded?

MUSGRAVE I don't know, I didn't feel that I had. I felt the day-to-day variation was greater than any effect I could see there. In other words, how tired I was on a given day, what time of day we ran it.

SAWIN

I think it might be interesting to look at the upslope going from no load to whatever, the 25 percent or 50 percent I thought some times that I did a little better job about coming up sharply and holding at the point versus coming up and overshooting and backing off. That's that day-to-day variation that Story was talking about.

LAFEVERS

The higher loads after the 10-second intervals, holding for 10 seconds and I'm talking principally about the last day when we went up to 60 percent on both biceps and the calf muscle. Did this at all - subjectively again - Did this all seem to tire you prior to the one 1-1/2-minute run?

MUSGRAVE

No.

SAWIN

No.

LAFEVERS

You just didn't get that feeling at all?

MUSGRAVE

No.

LAFEVERS

Strip chart versus the scope that you used on the Tandberg. Would it be more beneficial for you to have a strip chart in there to look at these things, or did you feel that the scope was appropriate?

SAWIN

I like the Tandberg.

MUSGRAVE

The scope was nice.

SAWIN

It's a very nice little recorder.

MUSGRAVE

He always looked at that thing, during the run.

LAFEVERS

Okay, the last question is - again a subjective type - What do you think about holding say a load, and it might be a 30, 40, 50 percent load, holding that load until complete fatigue? Say we're in a mission context, and I wanted to, for example, check the capability as you went through a mission for holding a particular percentage MVC. I would expect that thing would to get shorter and shorter as you went through this period of weightlessness, perhaps. What do you think about doing this thing in a mission context? Would you be - do you feel this would be a big constraint on the activities you might have to do later on? I know that you depend on the type of activity, but what are your feelings?

SAWIN I don't think it would be any . . .

MUSGRAVE It's a matter of motivation, though, if the guy's motivated enough he's going to hurt himself. He's going to come out very stiff. You know when you quit is not just a function of physiology. It's just a function - probably a bigger function of motivation. It's a hard end point. I think it's a very difficult end point to reach. You know, the state of mind and that kind of stuff, I think that would greatly influence it.

SAWIN I don't think - If we hadn't been as high as we were emotionally Saturday night, we wouldn't have gone the 2 minutes on the 60 percent on the leg because it hurt.

LAFEVERS Did both of you feel that the 60 percent for 2 minutes on the calf was just about maximum?

MUSGRAVE It was getting there. It was on the voice tapes. They smart, they smart; there's no doubt it smarts. I was surprised after 5 seconds. And I said, "My God, I've got 2 minutes to go."

LAFEVERS How about the 50 percent on the arm. I know you did that a number of times during the mission, 50 percent on the arm for 1 minute.

MUSGRAVE That was easier. In this case, right, it was easier than the 60 percent on the leg for 2 minutes.

SAWIN Easier, but position of the rest of the torso is more critical because of recruiting help from the rest of the shoulder girdle. Now when you get your leg in that device, you're pretty well going to use only gastronemius and soleus, which is what you want. But with the arm it's more variable as to the what assistance you can get from other muscles. For instance, Earl, I don't know how you feel about - Sometimes I would clench my fists and I don't know if that impacted things or not. But the reason that I did it is because what I wanted to do subjectively was reach out and grab the side of that restraint. You know I'd come up with the force level I was supposed to beat, and then I'd stabilize it. I wanted to go over and just clamp. And then, you know, hold it right where it was. So to get away from cheating like that for myself, I had to clench my fist and then if my fist moved side to side in there, that didn't impact me anything.

MUSGRAVE

Unless you sunk your nails into the steel, there wasn't anything to grab.

LAFFEY

You tend to, on those loads - you tend to, especially if they're high in the arm, you tend to have tremor as you continue to hold that - did you see if this improved as you went through the mission?

MUSGRAVE

I don't think so. I'm sure it effected the cardiovascular data. You could see it on every signal.

ALEXANDER

The addition of the limb blood flow, to X-2 combination there is very interesting. But there's been graphic responses in the arm blood flow that I think that you should be aware of, and talk to Wick and the PIs on that. But you can see almost an anticipatory increase in flow, almost a hyperemia that when you guys were gearing up to go, I'm sure you were tensing. Then you would see probably a 30 percent increase in limb - in arm flow before you actually cranked up on it. Apparently, the whole skeletal muscle bed was opening up, you know, just almost on a yoga-type thing.

MUSGRAVE

What you ought to do is study on both arms when you're going to do the exercise with one arm, is there is a selective improvement in the circulation on the arm that you're anticipating on using? You know the whole system's getting up for it.

LAFFEY

This is why as I indicated to you earlier that we ran the 50 percent 1 minute on the arm, because I wanted to compare the differences, if I can in blood flow.

ALEXANDER

Well, there's good information available to you you know if you can get that out and get it time-sync'ed.

LAFFEY

In fact, I tried to get a hold of Lou for the Saturday run, and try to hook it up and some way read the values on the calf with that heavier load of 60 percent for 2 minutes and see what happened. That's all I have and again and I, like the others, I'd like to thank you for a real fine job. The data that we've seen so far looks just precisely what we would have expected. Good baseline data. We've got - I think we got seven, - we've got six runs and one protocol on you plus that additional protocol and we can make a comparison there between on 40, 50 and 60 percent on the

calf, we'll only have one run maybe, but at least we'll see some comparison.

MUSGRAVE You might look for a little deconditioning effect. I've been running every day until going in this thing, of course, I didn't run any in there.

ALEXANDER Dr. Frome is onboard for X-13 now.

MUSGRAVE Bill, it went swell.

CLARK I had problems.

FROME They were two problems apparently. One time the hose, or the tubing was crinkled so I guess the packaging was the problem there.

CLARK It was all the same problem, I think, Bill. I started off on the second run, and I wasn't getting much collection on the rinse. And I found that the tube had been pinched apparently in the packing, and the flow was almost completely restricted there. I tried to open that up and I had troubles there, so I reversed the two lines. Put that pinched line over on the vacuum side and used the other line as the collection line. And even with that, I had to hold the tube to keep it opened, to keep the vacuum on there. Because as I would salivate in there, the vacuum would go away when it was pinched . . . the secretion into the tube. So it was a packing problem, and it took me about 45 minutes to get a good collection on it because each time I thought I had the problem solved - And I thought initially it was the position thing that we'd run into before, but it wasn't. It was that pinched line. And each time I thought I'd found the problem, I had to recycle to the rinse portion of it before the collection. So it was just the packing on the pinched line, and I think that was the only problem.

FROME Did you have one that worked very well?

MUSGRAVE Well, I didn't even give it - That one we had was such a goer, such a good one, I mean it never, you know, it did it. That as soon as I had any problem with the other, you know, there's no sense messing around - go with the the other and it worked. I think like the very first training session we might consider a manual placement when you've got a motivated disciplined trained crewman. And

if you'd like to stick it on the other crewman manually - You can't miss that way, you can put the center of the orifice right in the middle of that thing.

FROME You're talking about placing without self positioning.

MUSGRAVE Yes, you might consider that.

FROME I think if you had someone, you just need some good vision to do it with. But I think if you had someone trained, there are better devices for that, smaller devices that are easier to place.

MUSGRAVE But they were - when you get a good one going that never misses -

FROME I was pleased my experience with these is that they're more consistent.

MUSGRAVE Yes, they were. In my case, the volumes were right there the same. Preflight inflight, they were right right about the same level.

SAWIN It was real easy to do, Bill. You know, there's not much you can screw up; either it's flowing or it's not. You change your candies(?) and you watch your times. It just couldn't be better. I talked to you a little bit about whether or not it was important to give consideration to doing this prior to or following the meal. And I think you suggested that it was best to be done fasting and at the same time each day.

FROME That was the best. I think that the most important is the consistency in time. Each time one does it.

SAWIN Well, the next time around, I think you should just request from the procedures people that this is something that's stuck in just prior to breakfast on the morning you want it. Because it's such a little impact on things, that it would be done.

MUSGRAVE Yes.

CLARK You might have noticed, Bill, that on that second run of mine, after 40 minutes go at it, my volume was considerably down.

FROME Yes, I think the sample will be okay, but I think as far as the flow rates it going to be . . . That's all I have. I thought that basically it went quite well.

MUSGRAVE 14. Do you want us to lead that one out?

SAWIN Okay, Mary and Dick again, you gave us great support on 15. I don't know - I can't explain why sometimes it's extremely easy to bring up a good vein for you and other times it was difficult.

HENNEY Well, as we were saying the other day. I think it might have been better if we had cut these out prior to the migration as much as 5 or 6 hours and put it on a plain agar and there you would have it spreading. You'd have a much thinner plasmodium. You get a better vein that way.

MUSGRAVE The great big, you know the great big sewer pipes, the great big ones **were** too deep in; you couldn't get that close to them.

HENNEY The big problem, I think, is the microscope itself, you really should have had a split beam microscope where you could see through the microscope and the TV camera at the same time. But we don't have a microscope like that on site; it would have to be a purchased item and probably should be considered core equipment.

MUSGRAVE Yes, we read John's memo.

MUSGRAVE It should be core equipment, yes. Three level, motion picture, TV, and eye.

HENNEY And if possible it would be nice to have still camera through the scope because there are certain parts of this experiment that, for instance - the plasmodium that you had on the shaker that you put on the sclerotia. This is a very interesting process where you get the sclerotia.

MUSGRAVE Yes, you want to get the time course, yes.

HENNEY Excysting, it's coming out, and it's a very interesting process that is also controlled by the same contractile protein. And if we could just take samples out, put them on the microscope slides, put these under, and get still shots of this. Even TV shots would probably be all right. We could actually follow this whole process of excystment from the sclerotial to the active plasmodial stage.

MUSGRAVE Could you take samples that output on a slide and fix it?
Will that give you the same thing, too?

SPEAKER No, you won't see your streaming starting.

MUSGRAVE Yes, I'm talking about anatomic characteristics.

SAWIN From our point of view, this is very interesting experiment
for a lot of reasons. One is that Story had been prime on
the thing up until we got into the integrated sim, when he
took a look at the checklist and there it was; it was mine.
So now I'd been going along saying, "oh yes," "Fine," "Okay,
we can do that." Suddenly I had to do it, so - -

HENNEY You did a very good job.

SAWIN Well, I don't know how well I did, but it took me a little
while to regroup and think about what I was supposed to be
doing that rather than just saying, "yes," "sure," "I could
do that if I had to," and suddenly I had to. But it was a
good example in cross-training and the reason for having
it. As Story pointed out on 11, maybe I could have given
him a hand there and cut some of the time down if I had
known more about it.

MUSGRAVE Have you looked at the growth in the flasks? Is it all
right? Have you looked at the growth in the flasks?

HENNEY Yes. They're fine.

MUSGRAVE They're fine?

GRAVES I think we picked up a lot of good pointers on how to im-
prove. One thing was what you said about the microscope
itself. Even if we had a split beam, tribeam, whatever,
we should have less - -

SAWIN Clear the turret. Get the other objectives off of it.

GRAVES Yes, get those objectives off of it when you . . . When
you took that oil inversion objective off you didn't plug
up that hole that was what was causing a big glare up there
on the - -

SAWIN We didn't know about that one.

GRAVES - - on the screen itself.

HENNEY There was a big white spot on it and I couldn't figure out where that came from.

MUSGRAVE I saw that.

SAWIN Right in the center.

GRAVES That glare was probably coming from the hole that the oil inversion . . .

HENNEY I would really like to get in there and try this now with a light, on and off, and see how that reading - we didn't really get a chance to get that TV.

SAWIN But, if that's true, though, I don't know that - I haven't really taken a hard look at the bottom of the microscope turret. I would think that the only light that could pass up through there would be through the objective of interest. If what you say or suggest is true, why don't you have interference any time you use a microscope, from ambient light? Maybe you do, I don't know.

GRAVES Well, you probably do somewhat, but the - if you look at the hole in the high dry objective - -

MUSGRAVE Very narrow.

GRAVES - - it is so, so, tiny that the amount of scattered light or stray light that it picks up is so small that you don't notice it, compared to the one - -

SAWIN How about the low power, though?

GRAVES Even that - -

HENNEY You have the objective off altogether.

GRAVES Even that, the hole in the objective is small compared to the half-inch or five-eighths inch hole . . .

SAWIN That was a gaping hole in it. The funny thing is that I'd just mentioned to Story that I'd done it, and why I'd done it. And we didn't think about it any further than that, I guess.

GRAVES

There are plugs that you can get that just screw right into that plate. We didn't think about that problem of when you were turning the turret there that that one was going to cause you problem in going from low power to high power.

SAWIN

Again, this happened because we'd always trained on using low power, until we got into the mockup itself. Then we found that, because the TV camera there, we had to use the high dry. That was the first time we'd gone to that. And that impacted the timing because the smaller veins that we were looking at, were probably more variable than the larger vein in terms of streaming frequencies.

MUSGRAVE

Yes. Our TV system . . .

GRAVES

They're influenced more - the smaller veins are influenced more by the larger veins than vice versa because you get a vein that might be flowing at a good rate in one direction and then because of the peripheral or larger veins going in an opposite direction tend to shorten the reversal time on the smaller vein. So this is why we were having a lot of interference here and we need to get a thinner plasmodium.

SAWIN

Because once we'd gone to the smaller veins, I observed occasions where there would be satisfactory streaming that it would stop totally, just quit, and I'd have to find another vein. And this had never occurred during the training sessions using the larger vein. Now they just cycled back and forth very nicely.

GRAVES

That one time when we had the very rapid fogging up of the objectives. I think that we both agree that it was a fresh transfer and the plate was really loaded with moisture.

MUSGRAVE

Yes, the older ones didn't do that.

GRAVES

. . . and once we brought the plates out and let them sit for 2 or 3 hours before we made that transfer, it let them dry out a little bit, we eliminated that problem.

SAWIN

I think it was very interesting, and I think you should continue to add to it perhaps ways of treating the medium or the plasmodium, to look at changes that might occur. In other words, rather than just look at zero g as it might affect it. Perhaps the changes in the medium, coupled with zero-g and having different test situations to look at.

GRAVES This is what Mary brought up . . . micro sclerotia . . . This was a nice first cut at it, and I think you can go ahead and really embellish it and make it very interesting and fruitful.

CLARK I've got one thing we didn't exercise it; in fact, we didn't even think about it. But the TV monitor system that was up on the aft flight deck was much clearer than the one that was down in the Spacelab module. Operationally, if there had been a TV downlink problem where there would have been LOS, it would have been possible to do that timing with the TV monitors up there?

SAWIN Well, you see, I could do it through the scope, too, Bob . . .

CLARK Yes, but if your time was taken up on another experiment - -

SAWIN Okay. Well, the man up on the aft flight deck could have done it. That's a good point.

CLARK In lieu of having the ground do it, it could have been done on the aft flight deck by a PLT or commander.

ALEXANDER Another operational consideration is that I don't think I ever got comfortable with this during the entire mission and that is that even though we would volunteer to count for you on the ground, if we appreciated some time line constraint. Maybe it was 7 o'clock at night and you were just going to lunch, there were a lot of reasons why we would offer to do it on the ground, but I don't think I ever got comfortable with the fact that we had to call you back to tweak the focus. That seemed always an unnecessary call to the crew and go back through the tunnel . . .

SAWIN You mean you'd like to be able to do it remotely?

ALEXANDER Yes, either that or live with what we've got. You guys are always super in saying, you know, if you'll count for us we'll come back and do the focussing, but it still is never comfortable for me to drag you away from lunch or dinner or whatever you might be doing to go back and run through the tunnel and climb the walls to do it.

MUSGRAVE You could be stuck at the microscope.

SAWIN To us, that's fine because I'm able to be eating instead of sitting there counting the reversals of the streaming, so I just - I'm really happy to come back and do that adjustment - or send Story.

ALEXANDER Yes, as long as you can send Story, I guess it's all right? X-15 alfa.

MUSGRAVE Thanks a lot.

CLARK The cardiac output measurement using radioisotopes. We weren't able to use the real isotopes and go through the real procedures this time, due to licensing problems. The PEs are here to give their support as they always were during the test. We wished we would have been able to use the real isotope and do the injections. We tried to follow the time lines and simulate the data using sources as they came down. The third day that we ran it, which was an optional thing, we had the equipment onboard to run the third set. I think it was because we weren't doing the real thing, but we didn't get the detectors positioned in time.

MUSGRAVE I'm sure it was because we were doing the real thing; we had never done it. If you don't have any data feedback, you can get sloppy.

CLARK Right. The injections would have went well, the samplings would have went well, and the measurement I feel would have went well had we been doing the real measurement with the isotope. There are several problems associated with doing this type of experiment. One was the license which we ran into - was the hurdle we couldn't get over for this test. In addition, any type of radioactive material that is used in nonsealed sources onboard of beta emitters or gamma emitters, that you should have core equipment for the processing of potential spills or doing swipes, counting, etc. And this is something that might be looked into as core equipment for the next test for general radioisotope monitor. That's about all that I have on it. Any questions? Bob?

SPEAKER . . .

CLARK No. I don't think a strip chart would have helped. It's nice to have something on paper available, but you've got a real good feeling for it on the rate meters. The rate

meters - On any type of isotope work, the use of the rate meter is less than satisfactory where you have the capability of going to digital data and getting firm data with good statistics. The rate meter is just compromising the accuracy of the data when you don't need to because the state-of-the-art is much further along now. A digital rate meter would have been more beneficial in the experiment.

NOLTE How about cable lengths? Could you get any feel for the probe lengths of the cable?

CLARK The cable length is - since we had the detectors in the drawer to be use with the sources - During the training sessions was the time that we got out and stretched the cable lengths. But the cable lengths would have been adequate with the gurney there. I just found out for the other experiment the cables did come in handy.

NOLTE How about the foam cones that we had made up? Was there any need for a probe holder of any type or do you feel that's pretty much up to the operator to hold the probe where he wants it?

CLARK I think they're going to have to be held, but again we were constrained with one g. In zero g, there would have been no problem with the restraint, with holding the cones.

NOLTE So it may have come in handy in that case.

CLARK Right. But in one g those cones could not have possibly held the detector because their weight they would still have to have been held, but in zero g it's very likely that those would have been adequate.

SAWIN Bob just flagged something that Story had mentioned briefly yesterday, and I think it's worth going back to again, and that's that gurney. If we hadn't had that, we would have been in real trouble.

ALEXANDER That was super smart.

SAWIN And somebody should start working on it, some sort of a gurney - -

NOLTE I don't think we want a gurney - some sort of a lightweight restraint system.

SAWIN

Well, no. We need something someone can lie down on at the normal level off of the floor. So that an individual working on him can get around him and can have him be comfortable - have the subject be comfortable, and have access to the various parts of the anatomy he needs.

NOLTE

Would it possibly be even better if we have one that's capable of laying down for one-g training and like a pole, a vertical mount for zero-g use where you could, say, move around better. That pretty well blocks the whole aisle.

MUSGRAVE

Yes. It may be better get the data horizontal in zero g, too. For any conditioned reflexes, which is an experiment that I'm interested in, an inflight tilt table. In other words, get the data tilting him in one g and then tilt him in zero g. I'm convinced you're going to see a cardiovascular response to tilting in zero g. Because for 40 years, every time a guy jumps out of bed, the cardiovascular system has got to get the pressure up, pump blood to the head, and make all these other responses. For 40 years, these things have occurred. I think in zero g when he jumps up like this, you're going to see somewhat the same responses.

ALEXANDER

Well, the diving seal reflex is a good thing. The thing I wanted to say about this, the inflight phase of this experiment albeit was Mickey Mouse because we didn't have the hot stuff onboard and we didn't have the full blown procedures. The PE's were there every morning. Bob and Elena were both out there at the crack of dawn. They were there going through the motions of this experiment as if it were the real thing. We didn't see anybody else. We didn't see the radiation committee that would let us do the experiment. We didn't get any help by anybody but the two people sitting down on the other side of this room and you guys ought to know that. But they played it 100 percent. And it was Micky Mouse, sure, and you were standing up there gritting your teeth, I'm sure, when you were sticking a sealed source in front of the detector and telling me I was seeing a brain blood flow.

CLARK

It wasn't Mickey Mouse to the extent that we operated it as far as the time lines were concerned. We filled the time lines with the times it would have taken to do the experiment. We went through the use of the saline solutions as if it were the experiments to fill the time lines to fulfill the handling.

ALEXANDER

Yes, but what I'm saying is that you guys, you thought through it enough to have recommendations of how they could improve it. And you were enough into the ballgame to play it when so did these two folks. But the people that wouldn't let that experiment go, never came around.

MUSGRAVE

The problem was aggressiveness on side of the PI payload organization. When we first ran into the PI on that thing, he didn't even know what the state of it was. He didn't know whether it was going to be done or not. And we started pushing right then for getting the radioisotopes and doing it for real. And then things started getting rolling, but I think that was only - Was that 3 weeks before going to run? It was extremely late, and that's - there's hardly any criticism toward the PIs, but attention to detail on part of just a few is one, but the other thing is aggressiveness to guarantee that by golly, the payload is coming down the line and it's going to get done and done the way they want it to. It takes an aggressiveness, too. And for some of the time that the crew was being the aggressive ones to see that this thing got done. And that the crew was fighting to get the science done. And this is one of those cases, that when we got down to the first session, the PI didn't know what the status - he had no idea what the status of his experiment was. He just thought well it's there, but it's not going to be done. So why do anything, and that's where we were. Now if we've gotten in 2 months before or 3 months before like the exposure to some of the other PI's, we could have said, "Hey, let's go with the real thing," and there might have been time to pull off the real thing.

SAWIN

There were changes in philosophy that occurred during the last month or 2. What happened is that about a year ago Arnold and I took some courses up at Baylor to qualify us to do nuclear medicine. And then we planned to start a series of studies such as this, using Phil Johnson as our umbrella. But when it came down to really doing it here, we needed a broad isotope license, which we didn't have to use technetium-99. There had been exceptions made for specific tests on flightcrews during recovery operations, and so on. And Bob knows the details of what the requirements are for getting that license, but it's not something that's simply done, you have to go through a lot of people.

CLARK

There also was an additional problem, in fact, one that was done with the license and the exceptions to the licenses were used for Skylab. And at this time, the - There was a change in the last year to the - of the Government agency that handled the licensing of this particular type of application from the NRC to the FDA and then back and it's all mixed up on who had the responsibility to do it. And therefore, the regulations themselves were unclear as to what the license required. But what was needed to be done to the the license to the appropriate state to use it. So that was part of the confusion also.

ALEXANDER

I'd like to clarify my statements. I'm not shooting at the PI's at all, because the PI's were there, and they did what could be done. But I am a little tweaked still about the lack of support that we got out of the radiation safety committee, and their nonwillingness to consider anything, except rights and procedures in case you broke the sealed source which I thought was a stupid exercise. Make sure the tape's running for that. It was stupid to worry about somebody eating the sealed source, you know. If they had taken the time and the energy required to write the procedures for breaking the sealed source, I think we could of gone out on a limb and gotten the experiment in here.

SAWIN

The PI's deserve a little ding on this, there's no question of that.

ALEXANDER

Well, they saw it as Mickey Mouse. They saw the futility of the radiation committee ever getting off of their rears and I can understand their response.

MUSGRAVE

No, they didn't see that at the first presentation, they were unaware of any of these things.

SAWIN

But in the . . .

MUSGRAVE

They should have presented the hard facts to us then, if they had been pursuing it.

ALEXANDER

Well, blame the Science Manager on that one because he's the one that's got to drive the whole thing toward the end, if he's doing his job.

SAWIN Well, there are two things involved, one is the legal aspects of doing or not doing the test, the other is the question of support by the PI's. And I would say that, Adrian LeBlanc came down and provided very carefully thought-out kits. So that the only thing they didn't do is that they were not present during the runs. Arnold, in defense of him, I got on him pretty hard the other day. And he had some personal family problems that precluded or at least made it more difficult for him to be around. I got on him because it's typical Arnold to fire everybody up and start something and then walk away from it. But I think in this instance there were some other related things that were involved.

ALEXANDER There were circumstances involved. Of course, Adrian living on the other side of town - -

CLARK Adrian, any time during the putting together of the experiment, just provided super support of it and worked with the team in getting the experiment together at a very late time.

MUSGRAVE Yes. He was good.

SAWIN And you know that Dr. Johnson is Chief of Nuclear Medicine at Methodist, he's not going to wheel down here . . .

ALEXANDER That's true. I'm shooting at our own isotope committee and their inability to get off of high center and get something done.

CLARK The point of it is that the buildup of the experiment took place over the Christmas holidays. And Adrian LeBlanc was out here about three times working with the PE's and getting that experiment together, and from the time they got the word that, yes, there was to be something done with the experiment. Adrian was out here practically every day that we worked with the PE's to get it together.

ALEXANDER Well, that shows what kind of guy he is. He isn't even listed on the experiment.

SAWIN Additional remarks, though, could be directed to Verne Bailey, who had a very negative attitude about it.

ALEXANDER That's my whole point.

SAWIN

George Armstrong had the same attitude, and Arnold at that point didn't want to use the real isotope. When we were before the committee there, we ended up, Bob and I, against everybody. We wanted to do it. They all had their axes to grind. I don't know all the reasons for it. All we wanted to do at that point was to assure that, in the future, proper steps would be taken to make this possible. There's no reason we shouldn't be able to do these things. This is where a lot of knowledge in biology is going to come, in use of isotopes, and so we were just trying to push the system to that extent.

ALEXANDER

It's a neat experiment and there's a lot of data to be . . .

CLARK

One of the attitudes on using isotopes for a simulation is that the exposure is not necessary. And there are a lot of people that are very conservative about the use of isotopes. However, the doses that you get from the use of an injectable isotope like in an experiment such as this, is equivalent to going and getting a few X-rays and things like that. Not a lot of reluctance on the medical community to take a lot of X-rays.

SAWIN

Two people there, Tom Haney and Phil Johnson, who use them every day run the two biggest labs in town, said, "Let's go, let's do it." You know, Phil was willing to cover it under his license. And the people who were against it were our own people. Let's put it where it is, that's it.

ALEXANDER

Exactly what I'd like to see get in the record. Well, on 16, do we need to spend any time debriefing that? Seventeen, the PI's are here. You want to talk about - Excuse me, Chris.

CLARK

I'll start off with a couple of things that happened, Chris, if that's all right.

SPEAKER

Do you guys care if we press on and finish the 20? It's a quarter to 12, and we've got to come back for X-21 in an hour and 15 minutes. And then give - Charlie Chassay has requested, and rightfully so, some debriefing on the core recommendations, since we've got a big job ahead of us getting the core built. It's up to you all, if you'd like to break and come back or we'll press on.

MUSGRAVE

Press!

CLARK Okay, a general comment on the buildup of this experiment and the integrating of the experiment and the test. I don't believe there's anybody on the PI/PE teams that worked any harder - and looked any harder at the detail of the experiments than Chris Keys and John Hugg. They put a lot of effort into very detailed procedures to minimize time that it would take to run this experiment. They were looking at changes in procedures that would save say like 30 seconds in the time line. They paid a lot of attention to detail. The problems - we only ran into problems on one day and that was on day 1. We never really knew exactly what the problems was. It was probably a loose cable. We verified cables, the system seemed to work. Every time thereafter we verified the flash units by at least two shots during the setup procedure, before we ever attempted to run. The first day or 2, it was kind of flail getting up first thing in the morning and hopping in for photographs. Actually it went off very well as far as the amount of time used to take it.

KEYS That's one thing I'd like to ask you about. How did the times - for setup, what kind of time it took, and how much time did it take to actually go through it when everybody was up?

CLARK I don't recall. I recorded in the log one night how long it took to set up, and I think it was on the order of 4 or 5 minutes. That was about day 5. For taking the photos, what would you say, about -

SAWIN I'd point out that there's a subtle impact here, that's not major but it's there and that is that one has to clear the area between those cameras and that means it takes other men to move hardware around [Chatter] It's a subtle thing, but it's there.

MUSGRAVE It's a one-g problem; in zero g, it's not there.

CLARK I didn't count that in that setup time because that area was cleared by these guys the night before.

SAWIN Some nights.

CLARK Some nights. Was cleared before that. And this is just the physical location of the camera and the checking of the flash units. We did have - so we lost about four shots

that we retook. And then they, on day 4 I believe it was, we loaded film overnight. We loaded the plates into the holders overnight.

KEYS The camera you had trouble with. You had trouble with unit B at the far end?

CLARK Unit B at the forward end -

MUSGRAVE - forward end.

ALEXANDER I'd sure say on that one, excuse me, to interrupt but when it comes to mind that's another plus for our onboard video. We manned - Not that you'd want to do it on this one - but we manned - on shift hand-over, back on the SMA - . . . was usually between 5:30 - 6 in the morning, just anticipating that you guys might come out of the chute a little bit early - Here sits Chris Keys almost in the dark room, and everybody else is asleep, except X-21 there's always up and running about that time of day. You never saw a damn thing the whole week, it was always blotted out because of the jocks and skull caps. You never heard one thing. They always came over about 8 o'clock and say, "Well, do you think they're through?" But he was always there, and he was always full of details about anything we had to ask him about that system.

CLARK That was kind of negligence on my part to report when we were done with it; but it went so smoothly most of the days . . .

MUSGRAVE We had a preflight agreement, we'd do it every morning and at what time. If you didn't bomb it you wouldn't say anything about it.

CLARK Again, in zero g, it would have been easier to set up the cameras, rather than having to lug them around.

SAWIN Cameras are fairly light.

CLARK Mmm, not so light.

SAWIN I guess that that's based on one night I said, "Story, do you think we ought to set these things up, for Bob?" And he walked over and said these aren't very heavy [laughter]. That's my data point.

CLARK

I've got to apologize to one of the flight directors for that particular thing, because we were coordinating the thing by seeing on the time line exactly when we'd be on the dark side of the Earth, so that the lights in the high bay could be turned off. And then when all the lights in the high bay were turned off, I was still complaining that all the lights weren't off. Lou was apparently looking around trying to find out what the problem was, and the problem was onboard. It was the 5 by 5 TV switching matrix from the aft flight deck that was shining down through the hole causing the problems. I took a jacket up and covered that over and that cured the problem. But the reloading took I believe about 25 to 30 minutes to load 24 plates which was a very reasonable amount of time, once I had things laid out and had gotten used to it, it went rather smooth.

ALEXANDER

That just shows again that you understood what you were doing, the whole purpose of why you were doing it. You knew you had bad shots. . . . You were able to go ahead and go into your next days film allotment and catch up later with the reload.

HUGG

I think most of our problems on days 1 and 2 seemed to be with our electrical connections. Once those were straightened out, everything apparently went smoothly. Because of the exposure and training that we had with you in so many sessions, you were able to spot those times when things didn't malfunction because of those connections and, as a result, none of that data was lost.

ALEXANDER

A little KCl on the connector always works. (Laughter)
Ask Chuck.

SAWIN

Those are two experiments, 15 and 17 out of our 20 that Bob covered - did 90 percent on.

ALEXANDER

There was always a warm feeling that he had them well under control. Well, Chris - Is that all you have?

KEYS

I think so.

ALEXANDER

Let's go to 18.

HUGG

I might just reinforce the point that the video coverage would have been useful. Of course, for part of the time you were working in the dark anyway, so that wouldn't have

mattered. But in the future, I think we might modify the system so that it would be unnecessary to completely douse the lights. That way we'd be able to monitor maybe from one location, anyway.

SPEAKER Or just give Chris a puzzle or something to work with (laughter) while he's sitting there in the middle of the night.

CRESS We picked it up one night on TV while I was there.

MUSGRAVE Yes you could, but we turned the TV cameras aside. Because we're in a jock for the photos; and you're naked on the scales and that one period you're collecting blood, urine, photos naked, you know, that type of thing, so we turned them both like this.

SAWIN That was one of the amenities.

CRESS No, I'm talking about before you guys got up. I'm talking about the setup of X-17 before you all got out of the sack in the morning. It was dark in there but . . . we had to change the f/stop or something anyway . . .

CLARK I changed the f/stop on the color camera.

CRESS We could see you doing the setup . . . I think that was on day 5 or 6 or so.

CLARK Again, that was usually about 3 o'clock in the morning or so when that was done.

SAWIN I think this is potentially a very worthwhile experiment. The technique seems to work extremely well and, coupled with the body weight, we'd be giving each day, you should be able to really make something out of it.

CLARK Along with the relatively small amount of time that it takes for the experiment.

SAWIN We're talking about interest in where volume shifts occur. This could really be productive.

DELUCA That kind of a situation, if you wanted an actual run situation, that's the kind of a thing that can be handled with onboard controls, of a video recording system and the reel brought back.

HUGG I think the importance is that it be in real time so we can help the person who's doing the experiment.

CLARK That has to do with establishing a rating system for the ground monitors.

MUSGRAVE There are other situations that would have been rated lower than that one.

SAWIN The outhouse mode? Mushroom time!

MUSGRAVE Mushrooms, they went fine. Dick, I'd have liked to have trained on them for a whole 7-day period, in the preflight period, with real mushrooms. And it all went fine, but the thing he pointed out later, the little nubbins I picked out that were the right size for picking mushrooms out, they didn't grow at all. They just stayed nubbins and some other mushrooms are really hauling ass. What he told me later on is, that those should have been harvested. Because, like for any plant system, whether it's grass or trees, you get some tigers that start growing and - whether it's a hormonal or just roots and resources that they gobble up - when they get going, they hog everything, and the others don't grow. So, apparently, he'd have liked to have those big ones just cut out of there. And I didn't know that, and I was sending TV pictures down every day. I'd put the mushrooms over in the vestibular chair and then send a TV picture down to everybody. So I thought I was sending down the conditions. But I looked at those big ones, and I thought, well, they're not the ones I picked out, because they were too big to pick out, but at least it's data for somebody. We are taking pictures, photographs, and sending them down on TV.

GRAVES We had two problems. One was the fact that those did get an early start and were causing that problem. The second thing, I do believe we had a high content of CO_2 in there, which also inhibits the sporophore formation. We're going to have to work on making sure that we get rid of the CO_2 and not dry out the chamber. As you all pointed out, we had the back glass open on that container that back portion was drying out. You'd have to keep switching that around.

SAWIN I'll tell you, if you'd mentioned that, Dick, we'd have whipped that over in front of that mass spectrometer and told you what the CO_2 concentration was.

MUSGRAVE Yes, we could have just put that mass spec capillary right in there.

SAWIN That's something to do in the future.

GRAVES That's something to think about. I didn't know . . .

MUSGRAVE We could also tell you what the humidity is with that, the humidity of the air in there.

GRAVES That's good news. I didn't know we had that capability; I would have liked to have known what the CO₂ content was inside . . .

SAWIN If you'd even real time thought of it, and said, hey, maybe it's CO₂, I bet we'd have responded.

ALEXANDER That would have been great.

MUSGRAVE We didn't know CO₂ was a postulated problem.

GRAVES We had three problems, we have to have a hot moisture content, a high humidity, 90 percent or so that's what the vaporizer thing was for. The second thing, you had to have less than 1 percent CO₂ content, and then you also have to have a cool temperature. Well, I think we met two out of three which was the cool temperature . . .

SAWIN What's a cool temperature? I think it was warm.

HENNEY It was cool the first day that we were in there but it got warm after that and it should be about 68° and it wasn't 68°.

SAWIN No, no, you were, you were probably at 75 or something like that.

GRAVES That was the air. What was the bed temperature though.

MUSGRAVE The soil temperature was 70, 71 every . . . It never got higher than that.

GRAVES The bed temperature stayed about 70 or 71 which isn't that bad. That isn't the critical point. I think the critical point was that we just built up too much CO₂, plus we had those huge monsters over there just sapping everything.

MUSGRAVE I think if I'd have run a whole week. I know you've got a hard time going to the farm and getting them at the right stage. But I'd have been glad to come over 15 minutes every day for a whole week. And I think maybe if you'd said, these guys are growing big, take them out of there, you know, I would have learned it. I would have said, yes, we want to get rid of those big ones when I pick out the nubbins.

GRAVES I think this was a kind of a lack of communication, I guess on my part as well as others. The times that you did the mushroom experiment, I didn't seem to be around, or very little. Or we would have seen this. I never did see a video or TV picture of you doing this. I also heard that you all had picked some to eat. I didn't know how many that you had and I just assumed that you had picked those big ones because it was them starting to grow.

MUSGRAVE No, I only took that one, because it was growing over a nubbin, and I couldn't get in there to measure it. That was the only reason we took that one out.

GRAVES Well, like I say -

MUSGRAVE We probably could have done better; we probably could have told you when we were going to do them. As it is, you know, that was one of those things, that I just dovetailed in, when I picked up 10 minutes.

GRAVES Right, and it was difficult to correlate time so that I was sitting there. If I'd ever seen that on TV, or Mary, then we would have zapped it right away. Hey, you've got to get rid of those big ones. Those . . . pins aren't growing too well. Check the CO₂. It was just a matter of timing, I believe, because we didn't get to see the TV.

MUSGRAVE Voicing down to the ground what the numbers were. I was calling down these things weren't growing any, the one's I'd marked down.

CRESS We did some video recording of that too we could have played back.

ALEXANDER Yes.

MUSGRAVE The checklist could have said, when you pick out those nubbins, harvest any other big ones.

GRAVES Right.

MUSGRAVE Okay, I guess we'll be super ready for the next one.

GRAVES Yes. We're working with our PE to get our chamber so that we can do some more monitoring and make sure that we can keep the humidity high, the moisture content in the soil high, plus get rid of all that CO₂.

MUSGRAVE. That's why we're doing these things, to learn.

GRAVES The reason I say the CO₂, did you notice on some of your stakes you know the little wooden pins . . . that you put in. That one in the back was just covered with mycelium.

MUSGRAVE I didn't notice that.

GRAVES It looked like it had grown hair. And this does this, when you have high CO₂. You get this real thick mycelial mat that grows up. You don't get any of aerial mycelium that then turns into the pinning stage.

ALEXANDER You think that would work on the MS? (Laughter) Put a paper sack over your head.

MUSGRAVE Stick my head in there 10 minutes a day (laughter).

GRAVES Well, I do believe that that was what was causing it was the CO₂, just because of this reason that from our data and our experience, when you have high CO₂ - You need high CO₂ up to the time that you want it to pin. Then you have to get rid of all of it. And this is what happens when you continue with the CO₂ being high. It just continues to grow this mycelium and nothing ever pins out, so you don't get any of the spores.

SAWIN In your monitor functions the next time, you might request then that you have a capillary attached to your chamber there that can be interfaced with the mass spectrometer, if one is available.

GRAVES Right.

ALEXANDER You also ought to pull out that conductimeter on a TPS and go see if it's working because Story reported every day pegged, 10.

MUSGRAVE It was 10-plus all the time.

GRAVES It probably was down in the soil. You stuck it down in?

MUSGRAVE As soon as I hit the soil. As soon as the center part of the probe hit the soil it was 10-plus.

GRAVES Okay.

MUSGRAVE I never saw anything else but 10-plus. There was a little resolution. It got to 10-plus faster on one end than the other.

HENNEY That's something that we had just put in as an afterthought. I don't think it's really going to work - the moisture meter - because there are too many elements there that affect . . . the whole system works on the different elements you have in there.

GRAVES Of course, there it could always be the thing that we were 10 plus I mean, it could always have been that moist and just looked like it was dried right up to the top of the . . .

MUSGRAVE It was dry just on the very surface.

GRAVES Just on the very surface.

MUSGRAVE But you pinch it up, it was wet.

GRAVES Just a tiny bit under that wet crust, or the dry crust, . . . you had your 10-plus, which I don't believe was our problem. I don't believe that it was moisture content that was our problem. I really don't. Just because of the way that the mycelium grew all over the place.

MUSGRAVE We learned a lot on that one. I think we'll be up a lot further on the next one.

ALEXANDER 19 and 20.

MUSGRAVE The chromatograph. The guys are here? That one went super. Boy, there are some really fantastic chromatographs here. We got the atmospherics, the urines, the standards, the serums. And that all went really well. And we had a special sample onboard, which wasn't something you normally sample and do on a spacecraft, but it was an unknown identity, to go ahead and tackle. And it was a neat exercise

for me to play with all the different - It really, you know, taught me some chromatography. The other stuff was coming down the line. But here was an unknown. We didn't know how much or what temperatures, we kind of narrowed in on the problem. Ended up - you saw - getting some absolutely super chromatographs out of it, steady baseline. The only problem, and I don't know what it was, was the transient - I call it detector instability - but I don't know.

BAFUS We've had that problem with that particular unit and we haven't been able to solve it.

MUSGRAVE I don't know whether it was electronic, whether it was a facility problem, whether it was glitches in the electrical power supply to it, whether it was glitches in the hydrogen or the helium. I don't know what it was. But there were times I could get rid of it by cycling between the cell voltage, flame, and off. Sometimes that would get rid of the problem, I don't know why. I just have an intuitive feeling it was in the detector part of things.

BAFUS I've had that problem and haven't been able to solve yet.

ALEXANDER When you changed your baseline to the other side of the chart, did that problem go away? It seems to me in my thinking through it, it did?

MUSGRAVE No. It was there too. I just went over there because I could get these peaks this high, you know. On that sample, boy . . . she'd zip up just within 1 millimeter off scale. My tallest peaks. Everything came right, you know, fantastic. So that was a good one. I thought that special sample was a demonstration that you could go sample any chamber or, you know, what you found or anything else like that, hydraulic fluid or anything else. Here was an unknown, I didn't plan to run it. I just had it there so seemed like a good exercise. But absolutely no problems. Must have gotten about 70 chromatographs in all. Something like that.

ALEXANDER How much ether evaporation you felt like you had?

MUSGRAVE It was plenty in some of those bottles; they didn't hold the ether.

ALEXANDER Was that fixing to bite you? If you'd needed more ether, were you in trouble?

MUSGRAVE I would have liked a bottle of ether and, of course, this wasn't a zero-g test. I would have liked a bottle of ether so I could fill my own tubes and come up with more. I was running out of it in terms - Had a total of ten samples, as I remember, but if you run a urine, there's three gone; you run a serum, there's another three gone.

BAFUS Did you have a refrigerator onboard?

MUSGRAVE Yes, we did.

BAFUS That would help the evaporation problem. It went real well for one that wasn't flight planned.

MUSGRAVE We got a lot out of it. The refrigerator reminds me of the freezer. The freezer was chock full. We didn't have enough freezer space. I took a photograph of that to show what it looked like.

SAWIN Orange Popsicles?

MUSGRAVE We had stuff . . .

ALEXANDER Those BMS samples were bulky. They were packaged kind of dingy.

MUSGRAVE There was hardly a cubic centimeter that wasn't full. We did not have enough freezer space for the biological requirements.

ALEXANDER Falcon tubes don't fit together nicely either in a rack; the BMS samples don't fit nice together.

MUSGRAVE Got any more on the chromatograph? Howard's happy with the stuff he saw.

BAFUS So far; he's out of town today. I haven't had a chance to really talk to him about it, but he seemed pleased.

ALEXANDER We have Dr. Golden at 1:00; and then we'll pick back up with core debrief after the X-21. This is X-21; Dr. Golden, the PI.

MUSGRAVE We never would have recognized him, of course.

GOLDEN Are they asking me or am I asking them?

MUSGRAVE You kind of have to . . . I guess we lead . . . Do we lead the presentation? Yes.

CLARK It's appropriate that it reverses on this one since I was the PI's representative in the sim.

GOLDEN I guess I know what PS 2 thinks about the experiment and control of the experiment. MS, how did you feel? Was the experiment really a big imposition on your time line?

MUSGRAVE No, it wasn't at all. It wasn't, no. I felt guilty, really, about not giving it a little more. I may have just run maybe a couple of monitoring functions. But, of course, we got all the SAA's, of course. We got about five of them.

GOLDEN Yes, I noticed that.

MUSGRAVE Fulfilling that . . . , I would have liked to have been a little smarter; you get right down to it, in the systems. One thing I'd have liked, one suggestion is, maybe I just didn't have enough experiments. I'd have liked a CRT overlay that I can plop on a CRT, and so I don't count rows and columns. Now you probably, with your experience, you probably didn't even have to count. You saw a number and you knew what it was. And this may be going into it too deep, but I'd like an overlay on the CRT that you can see the number. But I'd like the overlay and that number, what is it?

GOLDEN The only thing we have room for on the screen itself -

MUSGRAVE No, I mean a piece of paper, a cardboard that you throw over it.

GOLDEN How would you feel about a CRT, say, that has room for twice as many characters? You could really have the name? Real honest-to-God, English name on the perimeter written -

MUSGRAVE An overlay would be fine with me.

GOLDEN Okay.

MUSGRAVE And just a couple other real nittys and that's handing over the experiment. There were a couple of things that weren't handed over. Like TP4 was up yellow. Well, the first time - I should have been maybe monitoring air-to-ground. That was these guys laughing. But maybe if I was more attuned. There was a lot of traffic on 21, and I tend to probably block it out, which you shouldn't be doing. But you know we're doing our thing down there. We're having our air-to-ground on our stuff. And I probably tended to

actively block out what was going on there, because I had so much going. And I'd like to hand it over, I'd have liked to have known when I went up there that TP4 was yellow and forget it. It's already been worked.

GOLDEN Right.

MUSGRAVE And there was one other that came up light blue, I forget what - But anyway I went up there and here's light blue, and I know it's no big deal, but I call it because I see it, and I could have saved some voice communications.

GOLDEN Yes.

MUSGRAVE The only other thing that got to us was the lens had been switched over to the other camera.

CLARK Yes.

MUSGRAVE We clicked off a couple that weren't in focus.

CLARK That was a PS2 error. Just had one lens for the close-up camera for taking the Polaroid photos and I'd moved it over to take black and white so we're on the Tektronics scope and had not moved it back prior to hitting the sack downstairs.

SAWIN One time I very carefully stopped the camera and took a picture, reached up to pull the film and I hadn't put any filmpack in it.

GOLDEN They always do that . . .

SAWIN I always try the empty filmpack.

MUSGRAVE I felt guilty about not participating more in the experiment . . . That's the way I feel because I like to run everything.

GOLDEN Yes.

MUSGRAVE And, but, when you look at the time line, actually Bob had more time than the three of us.

GOLDEN Yes.

MUSGRAVE He helped us out an awful lot in life sciences by filling in the things that any one of the three of us could do.

GOLDEN That's one of the real advantages in a multidiscipline mission, I think. We could have set up the SAA program so that you could have typed in a time, say previous to any one SAA to initiate it or deactivate it. We chose not to do that, for a couple of reasons. One, there wasn't time to write the software. But, the other reason why was at least to my thinking. There were many similar experiments where we could not predict the occurrence. You know, you could not initiate it remotely. You'd have to have somebody there watching when it happened.

MUSGRAVE I'm real glad we did that; I'm real glad we did that.

GOLDEN Since I have a kind of a slight interest in astronomy and maybe technically involved in it sometime, I'd like to ask you a couple of questions about how you feel about pointing things?

MUSGRAVE Pointing missions?

GOLDEN Yes. Missions where - Suppose our telescope actually had to be oriented. You know that the SAA was a - was a bother for you guys, you know, because it seemed to always come when you were cabled up or something, you know.

MUSGRAVE Yes, but it ended up I felt I didn't do enough of the experiment; I was glad to have it.

GOLDEN Okay. But suppose that there were - let me, just give a for-instance situation - suppose there were not four SAA's a day but a couple of dozen. You'd really - What do you feel? Do you think you would really have to have a dedicated PS to take care of that, or could -

MUSGRAVE Probably a CDR or PLT right now.

SAWIN Somebody - other than us.

GOLDEN Okay, that's a good point.

MUSGRAVE No, it could be us, but probably CDR or PLT.

GOLDEN Yes.

CLARK CDR and PLT will be up there.

MUSGRAVE I think like we've been learning all along here, you've got to get the whole gang of people together and look at the mission.

GOLDEN Yes.

MUSGRAVE For a given time. There may be biology PS up there and a CDR is being run on a cardiovascular experiment.

GOLDEN Right. Yes.

SPEAKER You got to let the whole task sort out.

GOLDEN Right. It's probably a good idea that all the crew know each other's functions as well as possible because then they can real time make adjustments to pinch hit for each other.

MUSGRAVE I just don't think we're going to get to where you load the bus up with all strangers and go fly. Because somebody's paying 25 million dollars, and they are going to want that back, if for no other reason. And NASA is going to be paying a lot of that and as in the past they're success oriented; they want success. I just don't think we can load the bus up with strangers. You got to load the bus up with a team.

GOLDEN You guys had what? About 3 months to really work together, right?

MUSGRAVE Yes.

GOLDEN Do you think that's an adequate time?

MUSGRAVE It worked for this one.

GOLDEN Yes.

MUSGRAVE But we didn't have mission training.

GOLDEN Yes, that's right.

MUSGRAVE We had individual experiment training.

GOLDEN Yes.

MUSGRAVE We had 2 days, maybe at the most 3, of mission training, where you sort out all the tasks and the real division of labor in terms of running things in parallel really shook itself out. But if you look at the results, we did amazingly well.

SAWIN None of us is off the street, literally.

GOLDEN Yes, that was the other thing I was going to say. The people involved are pretty well attuned to each other's activities. And this really helps.

SAWIN I'll bet it would take 6 to 9 months to take a PS from a university environment, or something similar, bring him in, familiarize him with all aspects of the program, then tune them in to a payload specialist.

MUSGRAVE Some aren't going to make it. Some people you can't do that with.

GOLDEN No matter how careful you are.

MUSGRAVE Yes.

CLARK The biggest emphasis on that would be to seem to be, to me, would be the mission type training. To look at the crew interactions -

MUSGRAVE That's where you're going to optimize . . . that type of thing.

GOLDEN Is it also legitimate to direct questions? A question has just occurred to me with regard to this complexity of operation. Carter, do you think we imposed an extraordinary load on the ground side of the system?

ALEXANDER Not at all, I certainly don't. As a matter of fact, I feel like we could have helped X-21 even more than we did.

GOLDEN I was personally very, very pleased with the access that we had to what was going on in the payload, the ability to, you know, just kind of horn in on the loop -

MUSGRAVE We were horning in. It's amazing. There's times both loops were talking.

GOLDEN Yes.

MUSGRAVE And you can channel your ear to listen to who you want to. And there were times it had to happen.

GOLDEN Yes, that's right.

MUSGRAVE You know, because we were pumping down real-time stuff and, God, we just had to have it down, and two voices going simultaneously back and forth and everybody getting the message, you know.

GOLDEN Right.

MUSGRAVE Another thing I'd like to say here. During training, we learned that this happened over a period of time. That's something else that you can't take a man out of a university and teach him. He's going to have to sit on some console, listen to multiple conversations on there and learn to pick them out; otherwise they'll never be able to . . . you tune your wives out the same way (laughter).

CLARK I might say on that that I feel a little edgy on that because it was during our balloon programs and our flights on that we had as many as 12 people on the loop with hot mikes. We've had to have procedure discipline on comm.

SAWIN There was a lot of traffic.

GOLDEN Yes, there was really was.

SAWIN Hell of a lot. And it was not that we couldn't get in when we had to, it was just a lot of traffic, going baa, baa, baa, all the time. So as Story said, we missed some things that, after a while you just try to forget it's there and go on about your business.

CLARK Those were things I should have taken care of in the handover.

SAWIN Not necessarily. It's just a fact of life. There was a lot of talking going on.

FERGUSON Did you all really have a handover?

MUSGRAVE It was a continuous process. There wasn't a formal handover on anything. We were living together.

FERGUSON Yes.

GOLDEN Maybe better than a handover is some form of status available for whoever comes up to look at the console whenever they do, and some way in our procedures of recognizing significant things that ought to go on our little status board.

SAWIN Perhaps a log?

MUSGRAVE A CRT card that you can erase on and he puts in blue and yellow. When you come up and look: Blue and yellow, yes they're there. Or something.

GOLDEN Because as I see it, there were many gray areas. You know, we did not have delineated responsibility that said you're responsible for X-21, because he's asleep. That would be an inefficient way to run things, I think.

MUSGRAVE You wake him up.

GOLDEN Yes, right.

MUSGRAVE You know, when sentry . . . , it's down at the bottom to wake him up.

MUSGRAVE We'd have been at him before going up the ladder, and then go.

SAWIN You find the scale is down by 1 from the tolerance set. You know based on conversation you've overheard the last few days, that the tolerances are somewhat empirical at best. So you know that the thing isn't crashing, yet you feel an obligation to inform someone, hey, low point's supposed to be 55 and it's 54 or something like that.

CLARK The rates did slip downward a little bit.

GOLDEN I noticed that and I don't understand it.

MUSGRAVE If you really had horrendous problems - He has to sleep sometime.

GOLDEN Right.

MUSGRAVE We'd have been taking those over and we'd have gotten exercised a lot more.

GOLDEN Yes. In a way, it's sort of unfortunate the experiment - didn't have more trouble.

MUSGRAVE Same with ours.

ALEXANDER We found out we were having trouble with the fan bearings during the mission. We started cycling them. Did that come out satisfactory?

GOLDEN Oh, yes, absolutely. The signature for problems would have been a particular set of digitizers in the experiment would have started to malfunction. We saw no clue of that throughout the entire mission.

ALEXANDER Back to your question, Bob. I felt somewhat remiss though in that RSA got treated like a stepchild.

GOLDEN Well, in a sense . . .

ALEXANDER It was easy to identify with X-21, but . . .

GOLDEN Yes.

ALEXANDER RSA had to wait on the availability of the Test Director loop to talk. I always felt like that RSA . . .

GOLDEN Well, you know one of the reasons which I guess I should have discussed with the test team, is that the facility of RSA was not what we intended for the mission. What we intended to have was almost an exact duplicate of what was in the payload specialist station. And it crashed the week before the mission, so we had to put our backup computer in there. I couldn't tell nearly as much from that as I could from talking to Bob. And using the Sony downlink. That told me a heck of a lot more than my backup computer did. So RSA didn't get exercised as much as it should have and it didn't contribute as much.

LAFFERTY We were doing what you would have done from RSA in the backroom with the Sony and the Polaroids.

GOLDEN If we were to go through this again, and that end of it was up, I think we'd find RSA being exercised a lot more. It wasn't exercised; the reason it wasn't exercised had nothing to do with the ease of exercising. It was just that the utilities that were there were . . .

ALEXANDER It was a good opportunity to evaluate a truly remote control area.

GOLDEN Yes, I can sure see from a PI standpoint that would be a very comfortable way to operate. With what limited visibility I had with the experiment, looking at the graphs that I did have, and talking through you and X-21 to the payloads, it was quite comfortable.

ALEXANDER I think that'll always stay, but I would recommend that you guys need a backroom loop where you all can talk to one another.

GOLDEN That would be very nice. We used that phone an awful lot.

ALEXANDER Not have to wait on availability of the Test Director loop. The air-to-ground has to be controlled procedurally, probably by the Science Manager, there's no reason why you couldn't have an SSR type loop.

GOLDEN I guess one other thing we better mention now. You guys encountered a lot of problems with mag tapes and things like that onboard, did you?

MUSGRAVE No, we didn't.

GOLDEN Oh, you didn't?

MUSGRAVE They were operational, some operational things.

GOLDEN Yes.

MUSGRAVE Some funnies.

GOLDEN I was wondering if you noticed anything else, any other - effects of the magnet?

MUSGRAVE EMI was extremely clean.

GOLDEN Except for detuning the color TV, I think.

MUSGRAVE Except for the walkie-talkies.

GOLDEN Yes, right.

MUSGRAVE That added something to the vestibular; it was the cleanest vehicle I've ever seen in terms of EMI.

CLARK They had isolation down there in the Spacelab module on the racks that we didn't have in power on the flight deck. We had no isolation up there whatsoever.

GOLDEN That's one of the reasons our engineering parameters bounced around a lot. They were getting a little noisy.

GOLDEN Got anything special to add?

SAWIN All problems were caused by me, not knowing how to use the camera.

MUSGRAVE You've been flying them balloon flights a lot. Do you think we contributed anything toward your getting ready for a space flight?

GOLDEN Oh absolutely. Without a doubt.

MUSGRAVE In addition to what you've already learned on flying them balloons?

GOLDEN Yes, because the ballooning operational environment is really different. The degree of discipline required for spaceflight. It's of course greater, because you've got a lot more going on. The methods of experiment control, I think, are going to be pretty much the same. Details of how you interact with the experiment, except that you have the interesting option of having somebody there with the vehicle there are some direct feedback mechanisms that wouldn't be practical.

MUSGRAVE You think you learned something?

GOLDEN Yes, operationally, we learned a whole heck of a lot. I feel very, very confident, in the configuration that we could put forward in a proposal. I feel very confident in our being able to support it and see it produce science from the ground, both ends of the loop in our experiment, the ground part of it and the air part of it. I increased my confidence in the sort of way I wanted to do it, and added some details that just couldn't have been there before. One thing that was interesting. We didn't have a software uplink. And, you know, we don't software uplink to the balloon gondola. It doesn't have anything to take software right now. It's going to have a computer in it soon; it doesn't now. But we did some software together, hand-coded software over the voice loop and that worked extremely well.

SAWIN Such as changing the SAA procedure on day 1.

GOLDEN And also, you know, manual patches to the program to adjust constants and what-not. That worked extremely well. I was very pleased. But what we couldn't do is uplink new source software, really elaborate changes to the code. And there developed a need in the middle - or desire, not a hard need; it wasn't a matter of an experiment succeeding

or failing - but an interest in trying some new things, and there wasn't any way to get them up. And you guys in the life sciences experiments had software uplinks, right? I think we really need that too. I think that general capability is very important. And to complement that, I think you need a machine on the ground that's identical to the one, if you have one, in the payload . . . You need the same machine on the ground as you have in the air. There's been several times I wanted to try a procedure I had no machine to try it on. And I was hesitant to uplink it because if we blew the flight software, we'd be left holding the bag. So that's something I definitely want to change. A mission rule for us is to have an operating ground system, at least from a software standpoint, identical to what's in the air.

CLARK

The thing on looking towards Shuttle, the things we learned out of it. I learned a heck of a lot from the test ops team on what procedures are needed, what information we need to get into the system, what information we need to get back, from crew planning, procedures, payloads, all of the different functions of the tests ops team. I think it will be invaluable when we start looking towards the actual Shuttle payloads.

GOLDEN

Another thing. We're really getting down to the nuts and bolts stuff, the lack of EMI problems caused by the magnet, or the small nature of them. I'll tell you that's a double-barreled shotgun for us in our proposal. If this experiment flies, it's going to be based on, you know, competitive selection.

MUSGRAVE

Did anybody else do any quantitative-type measurements on EMI except for what we did in integrated tests in the whole week? Of course, you can look at the data. But it was really clean; that's the cleanest vehicle I've ever seen, from what we can see.

MUSGRAVE

Has there been anything else in terms of a quantitative look at EMI?

LAFFERTY

Bob was speaking of the experience in meshing the tests ops team. I think probably the only element of the tests ops team that we didn't mesh well with might have been the safety people.

GOLDEN

Right (laughter). Nobody does. It's been that way for years.

CLARK I wasn't aware of all that's going on.

MUSGRAVE Neither was I. I still don't know what the hell is going on in that area. I guess I've got to read a report or something.

DELUCA No, you don't have to read the reports; we can talk about them.

SAWIN Is there a safety man in the room? (Laughter)

DELUCA It doesn't matter.

CLARK It's going to be transcribed. Let's talk about it, I'd like to find out more about it.

GOLDEN Well, I guess I can do a confessional right here. We caused a lot of distress in the safety . . . We caused a lot of distress as far as the safety officer is concerned when we topped off the magnet. A number of the things he didn't like, some of them which I really agree with. You know, a group like ours tends to get a little bit lax because it's been doing the same thing for so many years. And it came from a university in the first place and so it was superlax to begin with and what tightening up it's done is because a little bit of manned space-flight environment has rubbed off on us. But for example, to us it's very commonplace, completely straightforward and very safe to transfer liquid nitrogen with surgical tubing. We found surgical tubing to be very safe mechanism. It doesn't crack at low temperatures, like some things do, Tygon. The pressures involved are usually a couple of psi's and the flow rates are very low. So, even if you were to have a line break or get loose, the quantity of LN liberated is so small that you couldn't hardly get a burn from it. I've never had a burn, I don't know.

MUSGRAVE Did they know that we had a big bottle of it inside the spacecraft?

GOLDEN Probably not.

MUSGRAVE I'm setting a Dewar on the floor, and pouring that out of the Dewar and grabbing it with a naked hand and putting it inside an oven. That's what the procedure read. It always astounded me but I kept doing it (laughter). It's a good thing they didn't. It would have brought the test to a screeching halt! If they'd saw that, Boy!, I just couldn't believe I was looking at that this stuff bubbling, and I says, "Hey, Chuck, you know this is really liquid nitrogen."

SAWIN I kept telling him it really wouldn't hurt him that much.

MUSGRAVE You grab the cup, you know, put it in the oven, it gets hot, and it's doing all this stuff. Oh well.

GOLDEN There are opportunities in what we do to get extremely bad cryogenic burns, but I don't associate any of those opportunities with the filling operation. Where you get into trouble is if the magnet transistions and somebody happens to be near the exhaust fan. Oh, I'll tell you, that's cooling. If you want some cool. That's gas cool, so you can't get away from it, like a liquid. But in any case, he objected chapter and verse, you know, quoted from the safety manual, to our procedures. And, you know, that's his job. Chapter and verse, we were violating them blatantly. I think the rememdy is to take a hard look at the procedures and they need a few more qualifiers. For example, one, transferring liquid nitrogen depends on what pressure you're transferring it under, what type of lines are safe. Not just categorically you need a 3000 psi line. In order to be as cooperative as we can and do our best, we went and got some 3000 psi, stainless jacketed line, proof-tested it to 30 psi and employed it in the transfer. We also have protective garments - don't have protective aprons, we should get some - but, you know, gloves and helmet and the guys were just sloppy about using it. And that'll change also. Those don't really impose a big restriction on us. Where we get into real problems in safety, for example, is when they look inside our payload, and they see Tygon tubing plopped all around. They want to know if it has been proof-tested. Well, no, it can't be proof-tested. I mean, it can be proof-tested prior to being installed in the payload. But once it's installed, it can't be proof-tested, because the pressures involved destroy the detectors that they're connected to. And since they're swage-lock, compression-type fittings, it's no good to proof-test them before you put them together. Well, the whole thing is rather ridiculous because the operating pressure is 0.1 psi. And the safety valve is 0.2 psi. But that disturbs the safety people and it's just because we've got to get the chapter and verse changed. I think we need to take a good hard look at the safety regulations. And they've got to go in both directions.

MANGOLD Bob, one of the problems on this test was, though, that safety guy that sat in on most of the meetings never showed up at the test, he was on vacation. The guy you had over there, his introduction to tests was he was over on the console. About day 5, I took him outside and talked to him for about an hour.

GOLDEN While somebody else worked (laughter).

SAWIN While they reloaded the LN₂.

MUSGRAVE Who was it?

MANGOLD It was Morledge. Jack had, he come on it cold. Bob was on vacation. So I told Jack that if he had objections like this, don't bring them up in the middle of the test. You guys are supposed to be here a week before the tests, and discuss it.

CHASSAY I think one of the things that might come about too is once we get into the slot of beginning to build flight hardware, safety and reliability and quality get involved at that point, so they know everything from conception up. And if they get in that late, chances are they would not have a history of data that you guys were working with.

GOLDEN That's a very good point, because we've had similar interactions with the quality people. And the reliability people. And I must say I am really pleased with those interactions. Because they start with hassles. You know, like, "Aw, God, he can't do that." Well, I'd believe I can get that . . . Finally they got so frustrated with us, they assigned somebody to us. That's what cracked the nut. We got some real understanding of what we have to do and some real understanding of what we do that really might be risking our chances of achieving what we're after.

CHASSAY Correct.

GOLDEN And the guy really pitched in. And he is still pitching in. And he's all over the payload and he's more than welcome to be, because he's taking a constructive approach.

CHASSAY Well, these people, of course, trained in that area. I'm not with those people, but it seems like I've slept in bed with them for the last 5 or 6 years.

GOLDEN Well, it seems to me that ought to be a very good thing to do with the safety people. And I'm, kind of opening the pandora's box there because, my God, a safety man in my building! He might not let me in. But nonetheless sometimes we need to work closer together to understand what each other's - He's got to help us understand what our bona fide safety problems are. And we've got to help him understand what limitations we have in terms of our scientific objectives.

CHASSAY A lot of this whole test I can see, and I have kind of a low-key effort involvement in this thing between PI, PE, and the crewmembers. Oftentimes, many of the problems have arisen just because a lot of people didn't understand the complexity of the exact facility until it got there. It was an evolution. All of a sudden it was there and there wasn't enough time to really work out all the small problems and details of this.

GOLDEN That's right. Those are some of the hard-to-put-your-finger-on things that you really learn with a sim, I think.

CHASSAY I think all future sims will be much improved to this one.

GOLDEN It's hard to imagine them getting better but I didn't have to work so hard on the facility. I didn't work at all on the facility.

CRESS That wasn't the only one, there were a few other incidents. Somebody got shocked.

GOLDEN I might just, for the sake of putting this in its proper perspective, we had a . . .

CRESS We didn't have a safety officer.

SAWIN Story said you really shouldn't have done that.

CRESS He wasn't even in there when it happened. He came back just about 30 seconds after it happened, looked over my shoulder, and read the log. And got on the phone and got Bobby Miller over there, and Bobby Miller called his boss.

SAWIN Story said, now I'll tell you exactly what we're going to have to do, and about 10 minutes later, uplink here it came.

MUSGRAVE We were open there . . . The cord was wet, you know, the cord was wet from KCl and it was obvious what the hell happened and we weren't going to let it happen again. It was our error in the first place. But I guess it's always best to communicate and go through those flaps. But the one other place where they introduced a the radiation spill, the tritium spill, you know, SIMSUP gave us. I didn't want to put that in right then, because, my God, the whole thing and no more of that business. And I knew they'd have shut down the BMS operation, which was a real OTR to gather data on the cross-contamination. So, that's why I introduced the spill after we'd already done it all.

SAWIN Plus it would have destroyed our whole day, which turned out to be the productive day. That was the only time we balked at all.

MUSGRAVE I just knew putting out a radiation spill would create a horrendous flap.

DELUCA And it did.

MUSGRAVE Sunday morning at 6:30, it would be less of a flail. It would be less of a flail than during a weekday.

DELUCA He was poring through the books for the definitions of near misses. Near misses in the emergency. Just who to call.

MUSGRAVE He got a near miss; the radiation or the KCl?

DELUCA No, the radiation, going into procedures of who to call. I was unaware that was in there. I didn't know whether it was for real or not.

BENSON Yes, it was for real. I gave it them Friday, but they didn't say, they might have done it on their own.

DELUCA It happened.

CRESS Somebody got mad at us when they found out it was a sim problem.

DELUCA The idea being on a test like that. Their opinion is you're really pushing the system, when you test something of that nature without somebody on the test team realizing that it was really that case.

SAWIN We knew it.

MUSGRAVE On the other hand, it's for us to play the game. Absolutely straight, right down the line.

DELUCA We played it up to making the phone calls, out of the place, to the appropriate people.

BENSON The amount that was spilled could be drunk by any one person without any damage at all.

MUSGRAVE Yes.

BENSON As I just pointed out that the man who is there, the same as you said, he's got to make a quantitative observation. Like if Story comes out and says, "Hey, Bob cut his throat." You don't stop the whole thing. You say, how bad? (Laughter). He's only got a little trickle here. First, you find out how much it is and how bad it is and you find it, and then you go from there.

DELUCA And we had one other one, that you will hear about, which was a gas chromatograph changeout, which was rather interesting.

FERGUSON The hydrogen?

DELUCA Yes, the fact is that in one facility, a man was on console, we had just got through talking about that we were going to have to do that, we started our talking to you about turning it off and all that sort of thing, and a guy just passed through the console, and he just said, incidentally, it looks like we have to change out. Zap, it was over. He was walking down with the tank.

SAWIN He had to turn the flame down or something?

MUSGRAVE No, I had turned it down. I cranked it back up again. Well, I had just gotten it down, I hadn't got the flame off, but I had gotten the power off.

DELUCA Well, we should've, you know, coordinated the whole thing. The point is, it was all over with while we were in the middle of the coordination. Because I saw him wheeling the tank out, you know. That's the other one. But what it does point out to me, and I did not attend all of the test ops team meetings, but it just seems to me like late in the game, before you go into the tests, I think there has to be a safety evaluation. And the point is, it says these are the notable items and test team - these are the conditions, safe, unsafe, things like that, so the whole team knows the game being played, rather than just an individual. I think that's part of a preparation process we have to go through.

SAWIN On the other example, is that the TRR, which provides the aviator oxygen, said that we've got to take a sample on that, check it. I said, well, I think it's all right; we've been breathing for 3 weeks. It's only empirical that - He had to his thing, I guess. They check all those cylinders when they are accepted on site anyway, so I just didn't

see what the big flap was all about. We go down to the bottle farm all the time, grab one, take it up, use it. We don't have them come over and check it, before we start on it.

DELUCA Was that before tests?

SAWIN Yes, that was a TRR.

CRESS We went through the motions of getting a safety concurrence and signoff on test readiness. I've even got the memo in there. Safety signed off on it and said there was no problems. They changed their mind.

MUSGRAVE These are all things that will happen at the integration facility. They are real things that are identified.

CHASSAY From a PE standpoint though, you look at every item. I don't know whether we had enough opportunity at this point. For example, you want to make sure that the bottles you got - I would maybe even go down there myself to know that we got a check on that before they're being used. I look at that kind of detail. You sure don't want an incident to happen that would . . .

SAWIN You want to make sure that when they hook up two cylinders for your experiment, in my case oxygen and nitrogen, they don't mix them. You know, when you start doing a washout on nitrogen you're good for about 30 seconds. Now that'd be a problem.

MUSGRAVE You'd see the data.

SAWIN Yes, you should.

MUSGRAVE I look at each printout. If I saw the nitrogen clouding instead of going the other way, and I got short of breath . . .

CHASSAY You know, too many times you have to redouble your work if you take some things for granted. Some things are worth putting a little extra into, to make sure that it's right. So the safety man from that standpoint was - I thought the point was well made. I was surprised, in fact, that they would have allowed you to use that out there because there's a quality man in the area, and he is somewhat versed on safety procedures and I'm . . .

SAWIN Al, we broke him during Skylab.

CHASSAY He should have really flagged that.

SAWIN He had great attitude when he lived with us.

CHASSAY That test would not have gone as quickly if Al had not been there. I'm being facetious.

SAWIN We're talking about compromise; Bob's talking about compromise, and that's what it's all about. A real understanding requires that that man be present during some of the earlier procedures. He can't walk in cold and evaluate it without flagging things like this, that might not have to be flagged.

LAFFERTY I'm sorry I brought the subject up (laughter).

ALEXANDER I think we should make a note that after the next sim we need a safety debriefing.

DELUCA Well, I guess the point is that all this did go on without the crew's awareness as to what these led to. This is the time for them to hear that.

GOLDEN PI/PE were the safety representative at the conference?

SAWIN Occasionally, at the TOT meetings.

CHASSAY Yesterday they were. I did not see a safety man here this morning, but they were yesterday afternoon.

GOLDEN That might be something that we put on the PI's list of things to discuss during the fairly early stages, like when I did that presentation to the team, fairly early in the game about what I'm doing and why. I probably should have ticked off some safety items. Like, yes, we do use cryogenics. Yes, there are high voltages. And just briefly discuss what the items are. And then later we can backroom-educate each other on what our problems are.

CHASSAY Normally they have at most of these experiments selection boards representatives in those areas. And right away they go back and notify their rep and then they contact you and then, hey, we need to look at your experiments. That's reasonably typical.

MANGOLD During sim 1, we had a training problem, I think that's pretty well recognized. During sim 2, look at the beautiful job the training house did. I think the same thing could happen here, and for the next sim Safety will be right onboard.

MUSGRAVE That's not just a sim to sim thing. That's a guy who had no experience the first sim and Brzezinski, who's been training since Mercury or Gemini.

SAWIN Okay, with respect to quality, Al Matties worked with me a long time and we used the same basic kluges in other test facilities. For instance, this pulmonary function equipment was used to test the ASTP crew. Al was our R&QA man on that. He knew it and I don't think it would ever occur to him to question whether the breathing gases were adequate or not. Because it was the same thing he'd been doing. It was the case of a new individual in a situation doing his job. It just happened at an inopportune time.

GOLDEN Bob, you got any detailed thoughts on what we did and how we ought to do it better?

CLARK Well, just one thing to mention. The way the experiment was designed, for this particular simulation, was one with many types of interaction levels, which you can have with the experiment. Would you like to comment on mode of operation?

SPEAKER We had as a payload specialist, as the PI's representative flying with the payload versus a monitoring type thing with more ground command ability. Would anyone like to comment on that?

GOLDEN Unfortunately, the thing that we have to observe the flux that we had to observe at sea level is much simpler from what you find in orbit or even in a balloon flight. There are only two species, basically, of particles that we can look at down here. At altitude, we have cosmic rays, which are nuclei of atoms of every species all the way up, probably, through uranium. Our instrument only covers through iron. So, one particular aspect of having a PI onboard would be for him to look in great detail at the larger data stream that would be transmitted to the ground; certain aspects of the data, trying to cover quickly the basis to understand where he ought to spend his observing time. Because you can select the lifetime of an instrument and dedicate it to a certain species of particles. That would be one possible area. The experiment is kind of unusual in that you can take any range of given participation. It can be totally automatic, preprogramed and just do the whole schmeer, or you can go all the way and not do a darn thing without somebody typing on the keyboard. And I think we were pretty close to that end of the spectrum. Bob is very

highly qualified as a operator of the experiment. So we got to, on this mission, to explore that end of it pretty well. The only major difference we could do is add in to that loop, the control loop, the capability of making physics tradeoff type of decisions. And I don't know whether we'll ever have a chance to really see how that works, unless we fly it.

MUSGRAVE That's the science, but in terms of the systems expertise you can never get anyone else up to the same level that you are in terms of the systems.

GOLDEN Well, that's true. You know, like for example, when we looked at a chamber sum distribution, which is a quality parameter. I was very pleased about how well it worked. Bob was showing me the graph with the Sony. And I could look at it, I could tell. Basically it looked pretty good. So he didn't have to make a judgment. I was still put in a position where I could make the judgment, even though I was remote to it, and I'm personally a little disappointed that it worked that way. I'd love to have to be up there to make the judgments.

MUSGRAVE Yes, but it's still another level.

GOLDEN That's true. And there is something to be lost there. During a balloon flight, for example, I sit on a console while the payload is remoted to me. I'm still in a very tight, high data rate loop in both directions with the payload. And that's interesting. I can try things, for example, that maybe Bob wouldn't have known to try. And that's usually what I do on a flight. We have two levels of support that we do during the balloon flight. One is very similar to the function that Bob performed during the sim. And that's more or less, keep it running and make sure it's basically healthy. And the parallel function is looking detailed at the science and seeing how goes it. Because you can change the trigger by deciding, this thing's not working on iron at all. Let's kiss off the iron and go after the carbon.

MUSGRAVE Yes.

GOLDEN And that kind of decision you have to be in a very - You've got 48 kilobits going this way and God knows how many going that way or around up here. It's a pretty high data rate of movement.

CLARK The type of loop that's being used is essentially two-loop operation, one a science loop and one an engineering loop. In the operation of a balloon payload, the operation is about the same as for Shuttle.

GOLDEN Some of the cross-checking procedures which possibly could have been done during the sim were just a little bit too complicated to attempt over the loop. I'd have had to get right in the guts of the computer, you know, changing things around a little bit. We didn't lose anything because of that, but we could have gained a little more than the nominal objectives of the experiment probably by doing it. I might say, by the way, this business with the uplinking through the GDP, was very helpful. Some of the more detailed hand patches, I wrote them out, and they got transmitted up. When I got a copy of what I got transmitted up, and bless their hearts, they corrected a few of my typos, and they let a few of my others go through. But they didn't make any of their own. So I'll vote for that form of information transfer.

CLARK Maybe the test ops team has some more questions.

FERGUSON I thought it was interesting. It was one of the few experiments where we really had a deactivation, kind of a real deactivation. I thought that added a little bit to the test.

GOLDEN I wish we'd have written the procedures a little more rigorously for that, but that's something you learn from the sim. It got deactivated okay. We got the straight data back okay. I'd be very anxious for the opportunity to play PS2's part in another sim sometime. I would like to see it from both ends. I think I could better contrast the capabilities of both positions.

MUSGRAVE You get to see a lot more, too.

GOLDEN Yes (laughter).

CLARK The waste managements system.

SAWIN How are you as a plumber? (Laughter) That's a prime qualification.

MUSGRAVE Bob's a good plumber.

SAWIN This isn't the White House type.

GOLDEN Yes, yes, I understand.

SAWIN This is the out-behind-house type.

GOLDEN I'll decline to make a statement. I feel happy. Are you guys happy? Have you got anything else?

JADWICK We had a little trouble telling when Bob was awake or asleep during the daytime.

SAWIN So did we (laughter).

JADWICK I know. But it gave us one little moment, maybe we discussed earlier . . . the activity indicator.

GOLDEN That's something we really ought to do. The ground team ought to be able to tell, especially on X-21 where you don't always have video coverage, what the flight team's doing.

CLARK Yes, a lot of times I would pop up there and do something on the keyboard. And that would lock the display that they saw on the ground and they wouldn't know I was doing it.

JADWICK This happened about three times too is that we'd be watching the display and it would lock up. We'd just say, ha, he's back upstairs.

MUSGRAVE He'd go back there. You'd call and say, "Is he awake?" We're not going to yell in there "Are you awake!" One of us is strapped to the table and the other guy is running something and it's fine to say it's quiet and dark in there, but he's upstairs doing something. And his sleep schedule varied about 5 or 6 hours when he'd go to bed or get up or he'd sleep twice.

SAWIN Maybe you need a downlink command that says he's up and working the system; you know, an indicator.

MUSGRAVE I think that's a real thing. It's really going to happen. I don't think you ought to flight-plan a straight rest period when you got a lot of interesting data coming in, and there's a lot of work to do on that payload, then you work it even though your flight plan is sleep. When you get done and you got it stabilized, then you jump in the sack.

GOLDEN What would you think of, for example, as part of our downstream data, to put the last command executed on the

payload, you know, and have that on the display that's on the ground? So we can see it. If the guy's acting -

MUSGRAVE You don't have that? You don't have the commands that we see on the CRT?

GOLDEN You have the engineering data there. But you can't tell what he's typing in on the keyboard.

MUSGRAVE You can't see that?

JADWICK All we can see is the engineering data freeze. And that tells us that he's typing and we saw that about three or four times when he was supposed to be asleep. So we said, ah hah! he's upstairs. And then one time it happened . . .

SAWIN Either that or Story or Chuck is screwing with it.

JADWICK We could see you guys on the TV - So the curtain was up. But one time it happened and about 10 minutes went by and no engineering update. So we asked. Carter was talking to you and we said, "hey, is he awake?" And he said "no, he's in the sack." So our display was frozen for about 10 minutes.

GOLDEN It had inadvertently assumed authority to type a "U" all by itself. Which froze the display. The "U" was waiting for the rest of the command.

MUSGRAVE Yes, we were not up there when that happened.

GOLDEN . . . and off we go again. So it seems to me that the downlink ought to . . . the last command typed, always. And then, if someone's typing in, it will give you the additional benefit of being able to follow the guy through, as well as just knowing whether there's activity there.

CLARK Or another way would be to note the time in one of the engineering displays that the last thing was done to the keyboard.

MUSGRAVE We always gave X-21 - that's mission training we didn't get into until we went to run - but we all gave them a call when we got up there. Are you ready to go?

CRESS I think one of the things that caught us off guard was the fact that during the simulation, 2 days we stuck pretty much by the flight plan in terms of time to go to bed.

Every time you got ready to go to bed you called down and said, "I'm fixing to go to bed; is there anything you want me to do before I go to bed? You did that on day 1. And then all of a sudden on day 2, you just went to bed about 2 or 3 hours early and we thought you were still up. You didn't tell us and we all thought you were still up.

CLARK Yes, that was an error on my part.

CRESS Changed your sleep cycle; I think you did it the next day; I think that night we asked you to let us know.

MUSGRAVE You had coffee in one hand and Quaalude in the other.

SAWIN We didn't know which way he was going to go, up or down.

CLARK There was some confusion on that one day about two Quaaludes. I've never taken a sleeping pill before in my life except in this thing. Quaalude did the trick to get me down but it wouldn't keep me down. I'd get 4 hours of sleep and then I'd be up wide awake. So that one day you mentioned that I took two Quaaludes, those were taken several hours apart. One to get me down the second time.

DELUCA The problem was, that wasn't in the list.

CLARK Yes.

CHASSAY That came on at the very last minute.

MUSGRAVE I asked Chuck to put those on, because -

BRADLEY The surgeon's list does not show those.

CHASSAY That was the only thing that wasn't on there because, what had happened was they got put in there at the last minute. Chuck wasn't sure that he was going to get them in, so we didn't add them to the list and all of a sudden they got in there. I was responsible for putting the list in.

MUSGRAVE There's absolutely no hangover from Quaalude. When you've got to get up and do something, you get up and you're alert. Amazing. On the other sleeping pills, you're left with a hangover. That one you're really alert when you get up when you got to do something. I think operationally it's a better sleeping pill than those others. But like we were discussing yesterday, we would have gotten more out of this thing if he had been on same shift with us.

GOLDEN You really think so?

MUSGRAVE I'm convinced.

GOLDEN Even with all the chatter that we did of course, you didn't hear the 11 o'clock late show. Oh yes, you did, you were, I don't know about Chuck there, but you were up.

MUSGRAVE But we were thinking, yesterday we were discussing that we would have gotten more out of it by every third night having one person - the SAA's were always during our day time - and during the monitoring function, every third night you'd have a different person wake up every 3 hours, every 2 hours or whatever, and go up and do the monitoring function. Bob, there is no question, would have been a more efficient individual. He not only had a circadian shift, but he had to put up with all the noisy clatter in the midday, which is real world. We're going to have that problem.

GOLDEN Yes, I'm real concerned about that.

MUSGRAVE Yes, a weak point. This came out in Gemini, but we're going to have to reinvent the wheel here and tell people it's a real problem, because Shuttle everyone thinks is a 24-hour machine.

GOLDEN Yes, that's going to have a big impact. Particularly on the people like the astronomers, where their days and nights come in 45-minute intervals. And if they have to sleep 8 hours out of that, they are going to lose one-third of their observing.

MUSGRAVE They are going to have to do it, but you're not going to have a guy who will perform as well.

GOLDEN Well, you're saying maybe it's better to just go ahead and lose the 30 percent.

MUSGRAVE It may be better. Although, you know the program office isn't going to think that way. They're going to have to run it a few times.

GOLDEN Yes, what's going to happen is going to fall into that mode by default.

CRESS We've got a resources problem that's going to bite you on that.

GOLDEN Sleeping places? And things like that?

CRESS . . . Power, for example shoving the power, if you put it all on one shift, there's a big power drain at one time and then on night shift you're shut down.

GOLDEN Do you think longer conditioning would be helpful?

MUSGRAVE I don't think that you can do it. The prelaunch phase, crew activity is really busy. There's training, there's integration, C^2F^2 and all that kind of stuff, it's all daytime. You can't turn the whole world around.

LAFFERTY What about putting a sleeping mask and a big pair of ear muffs on the guy?

MUSGRAVE We had earplugs and we had masks. And we're working on designing the sleep station so a guy really can cocoon. We'll work all those things. But it was a good exercise, even though he really suffered.

LAFFERTY We were using those on this mission, for this sim.

MUSGRAVE Yes, we tried out the earplugs and they helped.

GOLDEN Well, listen, I want to thank you all very much. The crew did an outstanding job and in the facility test team. It was a great experience for us, I think it really helped our experiment a tremendous amount.

CHASSAY I'd like to ask a question before you guys leave, if you don't mind. We're getting ready to discuss core equipment for life sciences pretty soon. I'd be interested in knowing what lines or what thoughts S&AD people have had in the astronomy, et cetera, type world for developing a core equipment type thing. Do you now have an active program; for example, life sciences just here at JSC, has most recently been issued a responsibility to go out and develop this thing. Already, there's two contracts that have identified something like, I think 400 line items, to be life sciences core. Which is a big effort to come forth this way. I just wonder if maybe S&AD has a similar type thing, maybe not at this center, but at other centers that's going on. Well, in these tests, if we run across discipline tests, it's kind of interesting to know whether or not there might be anything that you guys may have that we may have. If we have a similar test to this one again.

GOLDEN

That's a very good point. In high-energy astrophysics, the lead center has taken the job of developing the support equipment. There is no real hard core experiment-hard experiment cores - that can be identified. It more falls in the class of experiment support equipment, like data processing units and things like that. It's more on the subsystem level.

CHASSAY

Of course, this is too, in a way. Like mass spectrometer, anything from refrigerator-freezer, microscope. It's very small items, but yet there may be something between the cross disciplines that can be shared as a core item. Say, on a dedicated cross-discipline basis.

GOLDEN

It's quite possible that there is a situation in high-energy astrophysics itself is that the responsibility for providing core equipment rests with Goddard Space Flight Center. And they're fairly far behind in the game. It hasn't been well funded and it's just not going very fast. Primarily for lack of funds. That's a problem that exists fairly widely in physics and astronomy, not just high-energy astrophysics. The shuttle development money allocated to basic research in the physics and astronomy areas, is very, very small. And so you don't find very mature program as far as core equipment and all that sort of stuff.

CHASSAY

I thought that I'd ask because certainly if we do these types of tests again -

MANGOLD

Did you utilize your CAMAC displays, CRT, keyboard, and so forth?

GOLDEN

Absolutely. My own personal view is a lot different from the general situation. The things - the techniques and what-not that we developed, a lot of them, I think, have a flexibility in an interdisciplinary sense. I would love to see them used that way and I'd love to help get them implemented.

CHASSAY

At one time, when we started this test, a lot of the PI's had their equipment in their labs. They had it stacked and they were somewhat reluctant to take it apart, disassemble it, and ship it over here and then reconfigure it using some of the things that we had identified as core. And I know there was a big reluctance, but all of a sudden it just started happening. I don't know who waved the wand or who waved the hammer, but it happened. And I

think as far as some of the items that we've been discussing during some of the experiments and other discussions here in the room, it seems like core is a viable mode of doing things. There are a lot of problems associated with it, but it's a viable means.

GOLDEN I agree with you 100 percent. The types of things that people in physics and astronomy think about as core is say a pointing system. The telescope itself.

CHASSAY Of course, in the life sciences discipline there's a similar type thinking.

GOLDEN As you were pointing out, even a common -- very simple things like keyboards, displays, and processors. That's core equipment everybody can obviously use and benefit from sharing. In the astronomy area in particular, there is a lot better-defined thought about what is core equipment. It centers really about the observational end of the business. And they haven't yet thought in detail enough to know what kind of controls or displays they're going to need. They're busy at the other end worrying about to point, what size apertures and f/stops and stuff like that. So, in a sense, some of the life sciences efforts in core equipment may very well result in spinoff for the other disciplines, rather than the other way around.

LAFFERTY Chuck, didn't you note that there were four PDP-8's on the bird?

SAWIN Just happened that we all chose the same very versatile instrument.

GOLDEN That brings to mind another thought with regard to the instrumentation. I noticed that a lot of the computers were idle a lot of the time; in fact, one computer could have done many experiments had the interfacing been properly set up.

SAWIN That was why we set ours up as we did, trying to anticipate. We had four experiments tied to one computer.

GOLDEN You did!

SAWIN 7, 8, 9, and 16. That was really the whole purpose of our being in this test, to show the integration capability of a good digital system, the flexibility of it. That was

really what the message was. That's fallen aside, you know.

GOLDEN That's a shame, because I didn't catch that. That's very —

SPEAKER Carter would know this because when we went to selecting experiments, that was our whole pitch was to say: In the past, we've done this and this and this as independent effort but now, let's pipe them all through this thing.

MUSGRAVE It's part of shop-type thing. All those experiments come from the same shop.

GOLDEN Yes. And what we need to do is maybe go one more step.

MUSGRAVE On the other hand, the dash 11, they are both in the same shop, and there's two PDP-8's.

GOLDEN There was integration there.

MUSGRAVE But on the other hand, the Oak Ridge does all the programming for the one. And a different company does all the programming for the other. But, again, that's kind of an organization-type thing.

SAWIN And another thing, we're always trying to find ways of buying computers and if you can get them delivered on a contract that's —

GOLDEN Amen! Brother!

SAWIN You have to figure all those parameters in.

DELUCA Several things occur listening to the conversation here about a computer of that type, common. The experiments computer in Spacelab is supposed to be versatile and help to do a whole lot of things, but you get into the integration testing and early requirements, you get into that game. That's one thing for integration of programs. Another thing is (and I don't know the status of these) but the point I'm trying to make is a normal keyboard operation versus the Orbiter type keyboard. That's a big thing that's been going on and on, and here we're talking about standard things, standard keyboards, for some reason I feel that we can't get that thing on yet. That's another thing. Hardcopy, you had them in there. And hardcopy is hard to come by in the Shuttle yet.

GOLDEN Those are good points.

SAWIN It's awful nice. Talk about saving time. Having a permanent record. And being sure that even if your disk blows you don't lose your data. And it's really nice.

MUSGRAVE It's nice for comparing. It's nice for looking back in the baseline data or how you're going from day 1, 2, 3, 4.

GOLDEN We tried disk recall techniques where you don't save the hardcopy, you save the softcopy and call it back. And that doesn't work nearly as well as hardcopy, because you can't hold it up to the light and compare it with yours.

SAWIN But there are a lot of tradeoffs until they find the suitable hardcopy. You know, 9 amps of constant draw, that's real heavy. Plus the size of it.

GOLDEN One of the aspects of multiple-use computer, which has been a real reason why it's hard to have them, because actually — That's the software compatibility. You know, if you have a central processing facility onboard or on the ground (either one) and it's a flight system, then you have to worry about qualifying the software so that experimenter A's software doesn't trip over experimenter B's experiment. And there is some real hope for that. Even the small computers nowadays are becoming available with core partitioning, where there is a virtual impossibility of this guy getting out of his sectioned area of core and smashing the guy's program next to him. And we've had experience with that type of processor now for about 9 months in the laboratory. We're getting ready to fly it in a balloon. I am extremely happy with it. If that type of software management can be implemented in the Orbiter, then the financial burden and the temporal burden, the timeline burden of qualifying people's software mutually will be eliminated.

SAWIN The next step we see in our own hardware — I mean if I could walk out of here now and do what I want to do for the next time — would be to go to the microprocessor dedicated to my experiment. Make that talk to an "8" [PDP-8] or an equivalent for downlink. So all we get out our particular experiment, instead of getting a hardcopy off of Tektronix we've found a very small digital printer that will print the parameters serially. — So that would be really all you had at the conclusion of the test.

Everything else would be shipped to an "8" or an "11" or whatever it may turn out to be, it doesn't matter, and then downlinked from there. But the individual experiments would be stand-alone with minimum readout capability, and the rest being dumped to the onboard system. That's the way we're thinking. Obviously, it varies with the individual's requirements.

GOLDEN Yes. Very much with the experiments, details and data rates, structure.

GOLDEN Did you cover them all, Carter?

ALEXANDER We even added one, we're going to talk about our core equipment.

* * *

CORE EQUIPMENT DEBRIEFING

MUSGRAVE

Let me just sock a few things. You got - or you probably don't have in the recommendations. I got a bunch of stuff in it on core. Some things are obvious, but we'll just get them down for the tape. And that's the multiple - turret microscope, photography, TV, and ICE. An oscilloscope for - a multiple oscilloscope that you can move around and that you got as a redundant oscilloscope. We used the vestibular one for the output but, you know, if you lose an oscilloscope at some experiment, one you can bring over there and plug in the input so that you can see the thing. And it's a backup. I think photographic capability on an oscilloscope is really neat. It's a real backup, if you lose telemetry. You may want it anyway or you may want it for documenting some diagnostic problems you have. A diagnostic oscilloscope as well as a data oscilloscope would be good. It will supplement the old multimeter where you only get the one shot, you can look at the trace. But a core oscilloscope with photographic capability, that can back up so many data systems, a whole bunch of data systems where you take motion picture of that storage scope or something. Color TV would be best . . . it's essential. TV itself, of course - -

CHASSAY

May I stop you just a minute? We had some discussion there as to whether or not - I think Carter brought it up - whether he needed to have maybe color TV piped down. Do you feel like there should absolutely be color TV onboard?

MUSGRAVE

Yes. Now the proteins was the only scientific data that was coming down. But you look at the first sim; there were a whole bunch of things. There were tissue cultures and the amoebas and the eggs and the blood stains were coming down, and we were doing differential counts on blood stains, and we could have sent down the reticulocyte counts in the real time this time. There's all kinds of things you can identify, that color TV is so - the black and white is impossible through the microscope. And also in terms of the dogs, in terms of looking at the wounds, and in terms of looking at subject's color, pallor, and

in terms of vestibular experiment, looking at the heads There's a variety of reasons for having color TV. Animal ECS was identified last time, that we've got to come up with an animal-holding facility onboard, whether it's dogs, rats, monkeys, whatever else; we need a common system. There's no reason for every PI to come up with that. Wet trash, I don't know how much the Orbiter is going to support us. We got to look at how much wet trash is generated by general Orbiter ops. First, this is a life sciences mission where you've got a lot of animals and other types of wet trash. It's possible Spacelab is going to have to come up with more than the bag system they got. In other words, you may need to take a half of a half of a rack and have a wet trash system if Orbiter can't support a life sciences mission. Zero-g fluid mechanics, like for dash 11. In other words, we're drawing blood and we got it in test tubes or the APEAS . . . and those things. And we're taking the test tube and we're getting a syringe and a needle into them and pulling it out. Maybe that will work in zero-g, I don't know. But anyway fluid mechanics and fluid-handling techniques, almost every biological experiment you're handling fluids. You're handling some kind of liquid. Now rather than having each, single PI have to come up with his own expertise and his own machines or whatever for handling this, I think that's something NASA ought to provide. The workbench for life sciences, we got to take a hard look at the workbench. They are coming out in the core segment of Spacelab and make some inputs to that thing. But we might have to come up with some mods. Our workbench is an absolute necessity, even more so this time than last time. Last time we had a bunch of shelves and you could go to one big experiment and pull all these flat shelves out and give you some work space, but the workbench was so critical this time, the dash 11, the dash 6. Grab all the bags and go over there and you need a really, really flexible capable workbench where you got test tube holders, you've got Velcro all over the place, all kinds of the right restraints so you can set that up as your own personal little lab, you know, for each experiment. When you're done, you move it all back into the experiment rack. Centrifuge is obvious. A freezer, we know we've got to have a freezer for refrigerators and 37° incubators, but the freezer this time didn't have - for this mission did not have enough space. I took a photo at the end to show how packed it was. And cultures is another thing.

You might want - even though you don't plan to take any microbiological cultures. I can't imagine having a bunch of animals and everything else in there without having occasionally some time to grow a culture. It might be a part of the IMSS.

CHASSAY You're talking about an incubator-type thing with a recovery system to bring it back?

MUSGRAVE Yes, that type of thing. A plant chamber, that's the same as the animal ECS. I think we're going to have enough. We ought to be able to support plants and that sort of thing too. Radioisotopes, we've already identified as far as the experiments but we ought to go through whatever you got to go through so you are fully qualified, licensed radioisotopic handler and any time a PI or experiment comes on that needs radiostopes we can say yes, we've been through that and we can handle it. Rather than each individual person that uses them have to go through that.

CHASSAY Yes. May I ask you a question with regards to that? Do you feel like - I made some notes from X-15 here where we would possibly need either . . . Monitoring on board or the stowage cleanup and disposal facility built onboard if we carried that type of thing. Do you feel like it ought to be that complete?

MUSGRAVE To me, that's about everything you'd need if you had a problem. You definitely need a storage system of some sort maybe, depending on the - -

CLARK Yes, but it would seem to me to be a segment that would need to be flown if you had any mobile radioisotopes onboard as opposed to single sources.

CHASSAY Okay.

SPEAKER But you also end up as some thing of a radiation source, itself.

CLARK That's right. But if you're going to carry anything like that, you got to have the equipment available in case you do have problems with it, to be able to monitor it, to be able to clean it up, to take swipes, to count those swipes, to do all that.

CHASSAY

Some of the things that I have indicated here, we did have this spill, we had no capability to really . . . that, if it were a bad substance we were really working at. As it turned out, it wasn't, but -

MUSGRAVE

That looks like a general area that we ought to take on instead of making each experimenter do it. There's enough application for it. Body restraints and something like the SMSA, the skeletal muscle apparatus, you ought to have a general-purpose chair or couch or exercise device or whatever else to position the body. Because otherwise you're going to be hanging out there on the leads. There are all kinds of uses for that, the cardiovascular, the dash 12, or anything else you're going to do. I'd like to see all those oscilloscopes have a common outlet, that when you want to plug what's on that oscilloscope to downlink TV, you can simply make the connection or throw the switch. It would be fantastically useful. Right now for some of them, we're bringing a Sony over and putting that, and of course you go through one other level of recorded amplification. It would be nice on each oscilloscope to have a place you could throw a switch, to downlink TV or bring it over and plug in the connection.

CLARK

Or just dial it up on the matrix on top.

MUSGRAVE

Yes; it's a nice way to get down to VG-X, that's one example. But that way you can pump down any oscilloscope you got onboard; it's really outstanding. If you're not an expert in that area, you could get the expert on the ground to take a look at your trace. Echo 2 telemetry is a good example of a CRT. It would have been really nice to have pumped the echo down. That's what I got. In my report, I'll be addressing all these things.

CHASSAY

Okay, like I said before, we are going to have to make a major expenditure in this area for life sciences, and I'd like you to maybe when you prepare what you will be preparing for the tests you might want to consider that. I have a few things that I would like to quickly get, because I know we've got a time problem here. The mag tape recorder, we used a patchboard-type arrangement. Did you find that to be a problem? And if it was a problem, do you feel like we didn't have tools to repair or change some of that, if you wanted to change some real time. Do you feel like if we went with that concept that we could actually make real-time changes to that?

SAWIN Well, there was no documentation onboard - you know they all got put together a week before we used them - -

MUSGRAVE . . . didn't have schematics . . . would take a crimper change the wires on that.

CHASSAY Okay. Well suppose for example, though, that we do have that capability for the next mission, do you think that sort of thing might be feasible to do?

MUSGRAVE Sure, we can build a patch.

CHASSAY Well, patchboard, itself, the concept is very simple.

CLARK I spent about an hour going through with the Northrup guys over there. The patchboard, how the matrix were laid out, the pin labeling, how to get the pins in and out. So if we had got into a problem on that, we could have made onboard repairs by ground direction listing what wire goes to what position.

MANGOLD There's a lot easier way to patch if you can get the type of patchboard that's mesh where you insert a pin. It's a lot easier to work with that onboard, than it is to try to put in two jumpers - -

CLARK Where was it at? You what.

MUSGRAVE The VG-X.

ALEXANDER Yes.

MUSGRAVE That was on the patchboard?

ALEXANDER It was in the uplink to you all - -

CHASSAY Thinking in terms of a zero-gravity condition, could you think of something that we may want to add. We're thinking about commercial purchase of equipment like this, that we may specifically add to this machine or, say, an FR-1300. Anything in particular that you can think of right now that may come to mind?

SPEAKER . . . FR-1300, I think would be good to have some playback heads.

SAWIN FM reproduce module. We had three or four of them, needed . . .

CHASSAY Well, my concern was things like if you get any freezing at all inside of it that you could tell. We had it set real low, like 1 to 1-1/2 degrees C.

MUSGRAVE Refrigerator?

CHASSAY Yes.

MUSGRAVE It wasn't freezing.

CHASSAY Okay. The types of restraints that we might possibly use inside there. Right now, I think everything was just laid in. For the next coming test, I think we could probably look at evaluating different types of restraints to be put in there, or tape, or Velcro, or whatever types that we can probably have in there. But I just wondered whether or not - some of them were in racks - I think you had some in racks, did you not?

MUSGRAVE Yes, we had racks.

SAWIN The Styrofoam containers for the falcon tubes worked very nice.

MUSGRAVE Yes. Some you push in. Of course, the BMS samples, they were just thrown in.

SAWIN You know, one piece of Velcro would hold a whole set of those falcon tubes in place. They were, in turn, put in the Styrofoam. Without having individual tube restraints out of Velcro.

CHASSAY Okay. Well, we're going to be looking at different kinds of restraints, probably for the next test, and I just wanted to get some ideas - obviously we'll be doing probably similar types of collection, for the next test. Freezer again, we had a full freezer and it wasn't recognized until just before the test that - I don't know who had the big roll of paper. Was it you? That requirement was not identified.

SAWIN That was in the refrigerator. We had an empty refrigerator.

CHASSAY An empty refrigerator?

SAWIN And a full freezer.

CHASSAY What all was in the freezer?

MUSGRAVE Blood, urine, saliva -

SPEAKER The number 9C samples, sweat paper, sweat prints - -

MUSGRAVE I got the photograph. We really had to stow it. You'd open the door and everything would fall out.

SAWIN But that chart paper, I suppose we could have flown without taking that spare, but it was just a conservative measure to stow that.

SAWIN Okay, we never used it.

CHASSAY That was never inputted to me so when I saw that the first time I thought well we don't have any problem, but as it turns out we evidently had more problems in the freezer area then we did the refrigerator. The balance scale that was provided, I guess, is obviously not one we could fly in zero gravity. The SMMD that we use on Skylab would probably be a similar type scale. But I was thinking of the types of restraints and everything for a station where you are weighing things. Would you have any ideas along those lines? I don't know exactly what experiment would utilize that experiment - that piece of equipment - -

MUSGRAVE The rubber mat on the SMMD would have done it all. You could have stuck a rat under it or sweat paper under it. I don't think it had the resolution for the sweat paper. The SMMD didn't have that much resolution.

CHASSAY Well, my question here is if we're going to set up some sort of balance mechanism we probably should provide a means of securing things around the mechanism depending on what you're trying to work.

MUSGRAVE That rubber mat would have weighed all the things that we would have weighed on this one.

CHASSAY The vacuum chamber that we have right now - its size - its size, was it adequate for what you used it for? Also, it had a viewing port . . . and obviously we're going to have to stick shut-off valves in this thing.

SAWIN It had a what?

SPEAKER A viewing port. It was larger then required for what we did. Much larger than required. You put three rats in there. That thing was probably a cubic foot in volume.

CHASSAY Okay. We're trying to get some ideas because . . . down the line as money becomes available and we can evaluate some pieces of equipment, we're going to buy and put it in there, and we consider core items. Most all these items here were provided - I asked the PE's to talk to the PI's, and we classified them as core if they were used between two experiments. And so the PE's talked to the PI's and got them brought over with the other equipment that came. So even though they were called core, they were not totally supplied by me, but we wanted to evaluate or get as much information so that we could go in and purchase some.

CRESS We're going to have airlocks.

SAWIN Oh, those rats mess up an airlock.

CRESS Have shaker to put the extra rats on.

CHASSAY I think we have learned something from that. Evidently there's got to be a better method for exercising that. The shaker itself - do you feel like you actually had to view the shaker? I didn't talk to Mary or anybody. You put it on there for a length of time and then - -

MUSGRAVE You can hear it.

SPEAKER It made noise and it was awful large.

MUSGRAVE If you're going to have a shaker at zero-g, you're going to need a special one. You want to shake some thing at zero-g?

CHASSAY. I don't know. It may be something they want to consider.

MUSGRAVE It's got to be something special, you've got to have a three-dimensional shaker.

CLARK . . . necessarily . . . displace more than one radius . . . rotation.

CHASSAY Well, in this particular case, I'm not that familiar with that experiment, but that would certainly come under something we might want to consider as a core item.

MUSGRAVE If we had it keyed to be sure it was still going so those things wouldn't die.

SAWIN As long as it read 145 rpm - -

CHASSAY Okay, so that wasn't any problem to you. In other words, having to see it. We could actually put it out of view somewhere possibly.

SAWIN As long as when the scale reads 145, it's really shaking. If you can't see it, you wouldn't know that.

CHASSAY How about the holders - if there were a metal holder on the end of the tube to clip the flask in place. Do you feel like that might be acceptable for what you guys were doing?

MUSGRAVE Yes, sure.

CHASSAY It seemed to secure it fairly well. We might want to consider that for holding other things too. We had some things in IMSS in Skylab, some little holders that were clip types, not . . .

CHASSAY Vector programmer, any comments on that?

SAWIN Works fine.

MUSGRAVE It's neat.

SAWIN You might want the other version of that that has the input standard 12-lead clinical. Just some people prefer it and that's never going to change. Everyone doesn't think the Frank lead system -

MUSGRAVE . . . the photographic capability -

ALEXANDER We are vector oriented here.

SAWIN It's a slick system, though. It's very simple to use and we had no trouble with it.

CHASSAY Okay. The BPMS, one of the things that I was - I noted down here was maybe the length of the hose between the panel and cuff needs to be - -

MUSGRAVE Yes, it needs to be longer.

SAWIN We've done that, Charles. It's just a simple thing, you only have to change the bleed rate and it affects slightly the pumpup rate. We have over in our cardio-pulmonary lab extended that on that same machine so it's a real easy thing to do.

CHASSAY Will you guys supply that?

SAWIN That was Joe Baker. Well, it was actually DE's instrument. We have two of them, Joe has one of them and you have one.

MUSGRAVE That's an experiment thing, there's no reason they can't go to the same data as everything else is going? Instead of manual logging.

CHASSAY Your comments on cross experimentation, you were making reference to that and I thought well, if you had that situation, you may want to extend the hose to take that into account.

MUSGRAVE Let it take data.

SAWIN That system worked as well as any of those that I have seen. Perhaps it's because it was new; I don't know. We all had those built at the same time, 3 years ago and we paid dearly for them at about 10,000 each, and I thought we had gotten ripped off. We've had a lot more trouble with ours. That one worked beautifully the whole week. It was just super. We got very few . . . systolics or anything.

CHASSAY For your work involved with the centrifuge, would you have any comments there that - any particular type . . .

ALEXANDER The fact that the valves stick . . . ether . . . safety.

MUSGRAVE Well you're loading ether in the other three tubes anyway.

ALEXANDER Yes, sure but . . .

MUSGRAVE Don't use the word ether on the loop. The other three tubes as well as the balance tube also had ether . . .

SAWIN Call it the solvent.

ALEXANDER That was their recommendation by the way to fix the KCl spill, to take all volatiles and all conductors off the spacecraft.

SAWIN That would mean all the urine.

SPEAKER And all the people.

SAWIN You haven't gotten to the most important one yet, Charles.

CHASSAY I still have my list. A little quicky here. We hit this the other day, about stationery supplies. How did you keep your own personal notes. Did you keep it with a pocket book or did you even keep it, other than - -

MUSGRAVE A spiral notebook. I replaced it - the flight - this is the preflight, a green book. The flight book was a bound spiral book.

CHASSAY Okay, I put an overkill of supplies in there, because I felt that as you got along in here there was going to be maybe one that you preferred - -

MUSGRAVE There were not enough pens, retractable. Playing with that fiber tipped, it takes two hands. You got to take the top off and then write. There was a shortage of pens which you could click. It was a little nitty but it ate us.

SAWIN I notice you had to scrounge so hard for that kit that you'd taken some back from Al Shannon's daughter or something. That's getting pretty hard up.

CHASSAY And all the supplies came in the day after the test started. Our secretary brought in those big old boxes of supplies.

SAWIN I looked at everything, I said, Story, this is the sorriest-looking set of . . .

MUSGRAVE It ate us because for efficiency, you station a pen to every log you have to use.

CHASSAY Right.

CLARK You're right, Loretta Shannon.

SAWIN You need a new secretary I think, Charles.

CHASSAY It might be the system. But she ordered them.

ALEXANDER Well, we sure found out that we had it sweet, when we were doing the X10, because we had a playback channel. As loud and as noisy as that head was, we knew we had a lot. But you guys have had the same problem.

SAWIN On the patch panels, I don't know how easy it is for one of us to pull the wires out, I never tried, but it seems like they should be more well protected than they were. All those wires just stick out there and you reach up and grab the panel and you just as well pull out a handful of wires.

SPEAKER But they are locked in console, it took a special tool to remove one.

SAWIN Fine. I didn't know that, because I never tried it.

ALEXANDER It doesn't look obvious, though, I'll tell you.

MUSGRAVE It's critical when we got to condition signals. It's one thing to look at the scope, and you get used to knowing looking at that signal, you know what it's got to be. But if sometime before, someone else changed the sensitivity on the scope and look there and it's reasonable when you're clipping hell out of it on the tape, it's nice if you can run some data and then run a playback and say yes, I'm there.

CHASSAY Okay, the next one I had listed is the time code generator. In particular, we had several aboard. I was concerned maybe with the position that they were in as well as the colors, and whether or not we might want to consider one or the other having the characteristics of being able to reset for a specific time frame that you might want to operate to. The running time, as I understand it, was not the test.

MUSGRAVE Yes. We went that way because we only found out at integrated sims, wasn't it? We found out the week before that the time code, except for the 12 - the time code was the one - we only saw that the morning we went in, I think on the first day of integrated sims was the first time we saw that. We said, what's that?

ALEXANDER . . . We started looking for where the thing was - -

MUSGRAVE It was the first day of integrated sims, and we said what is that? And that was the one that time-coded all the tapes except for the 12 tape that was on that one. We had trained throughout that that one over by the cardiovascular was the one that put the time code on. So we would have liked to trained and had a checklist-clock correlation, the same as your reentry burn. Your phase-elapsed time is what you wanted. And we would have like to have had a correlated be between the clock and the checklist at a certain zero time instead of GMT. We had to go GMT on that because we just didn't have the time to regroup the checklist.

SAWIN One thing about GMT is the way we were working, the day changed sometime in the middle of the afternoon and, by golly, if you put down what GMT day, hour, minute is, a week later you know when you did it. If you just put time down, it doesn't mean anything.

CHASSAY Well, I'm thinking in terms of one that may be relatively close to you that if you want to punch up for a 30-minute period and you want to knock off after that time at the end of an experiment, you're sitting there looking at it and you know when you're finished. Some of the individual experiments did have - I think this . . . one of them. Who was that, Bob Thirolf? 12 had it.

MUSGRAVE I'd say code it with GMT but have an event timer you could use and use the checklist correlation to an event timer. That would be the best of both worlds.

CHASSAY Right. How about its placement in the lab right now? Do you feel like that was a problem to you trying to visually?

MUSGRAVE It wasn't great, no, because we had the other one set to GMT.

SAWIN Even with the two of them, it wasn't perfect. I don't know what better suggestion; it depends on your vision, I guess - -

MUSGRAVE You have the clock in the core segment anyway.

SAWIN Perhaps somewhere around the middle of the lab and up high so it would be really visible from both sides.

CHASSAY How about its color? Would a particular color be more advantageous to you? For example, red, white, or green or -

MUSGRAVE I like that.

SAWIN Nixie tubes versus some other type of display. Doesn't make that much difference.

CHASSAY Okay, it wasn't a noticeable problem then. Are you color blind, by the way, Story? They were talking about the - -

MUSGRAVE Who? (Laughter.)

CHASSAY - - doing something with red the other day and - -

MUSGRAVE I had the goggles on.

CHASSAY Oh, okay. I missed that part of it. I heard you saying you were . . . then all of a sudden you had a big syringe of blood here. You said -

MUSGRAVE That's the vestibular goggles.

SPEAKER Okay, the next one I would like to go to was the refrigerator. At the time that we tried to identify these things, we obviously tried to keep the volumes available small because of other problems that we envisioned having but, for example, at one time we thought we would just be overloaded in the racks, and there was going to be very little available rack space. There was not much in the way of refrigeration in freezing required. Some thing like a cubic foot or a little over that, and as it turned out it was very - -

MUSGRAVE You know those urine folks.

CHASSAY I think they upped their requirements.

MUSGRAVE The urine and the blood folks are always going to come in.

SAWIN Well, maybe the approach though is the one you took and had several units of that size or something. You pay a little penalty in usable space that way, but at least if you don't need the damn thing onboard, you haven't got a whole rack full of them.

MUSGRAVE . . . also know you need smaller falcon tubes. Out of that 25 or 30 cc's in there, they're only going to use 1 or 2.

MUSGRAVE We also need a mechanism for - this is probably more facility, but for attaching the checklist to the experiments to hold the page open where we want, like a clip.

CLARK Okay. Spare Velcro and gray tape. Gray tape got unstowed somehow.

SAWIN Yes. We didn't have nearly enough tape.

MUSGRAVE Yes, this has been the first manned spaceflight simulation that they didn't have gray tape.

CHASSAY We had one roll - -

SAWIN No, yellow tape.

MUSGRAVE No gray tape.

CLARK Gray tape was in there during the dry runs and somehow or other before we went in there it got pulled out.

BOOHER That's amazing.

MUSGRAVE It's amazing we could survive.

BOOHER You've set a first.

MUSGRAVE The tape we had, it would last about 15 minutes. We're taping our cue cards and they're falling off in about 15 minutes. You would hear this clump behind you and look around and there's a cue card on the floor.

CHASSAY What was the tape that you were using?

MUSGRAVE Masking tape.

SAWIN Yellow . . . tape or the masking tape, either one.

MANGOLD How about in the medical kit? There was 2-inch adhesive tape.

SAWIN We didn't get into that I guess.

SPEAKER They were afraid of it.

SAWIN It was the same; it didn't have very good adhesive properties.

MUSGRAVE It didn't hold so good either.

SPEAKER Stuff is pretty sticky outside.

MUSGRAVE It didn't last.

ALEXANDER Sticks on itself super.

SAWIN It's a zero-g phenomenon.

CHASSAY I think this toolkit thing didn't really get exercised properly because a lot of the PE's didn't see their equipment until the very end, and I think we're going to scratch up a lot more tools for the next time. Some of the things that were identified, for example, the use of the little penlight that we had in there for the dual shift thing. Help you go around looking at - for things in the mid-deck region while Bob was asleep. Those things, I think, we can certainly provide.

MUSGRAVE We could have used one per crew plus a spare.

CHASSAY Right. Okay.

MUSGRAVE Of course, on Apollo we got those little ones.

CHASSAY Okay. Any large flashlight. Did you have a need for a large - something to look behind a panel that you may have removed or any thing like that? You didn't get into much in the way of troubleshooting so I -

MUSGRAVE You need a flashlight, we know you need that.

CHASSAY Yes. What I'm trying to get at is do we need a big flashlight or -

CLARK We used the big flashlight, but it wasn't anything that the small one couldn't have been used for.

CHASSAY Okay. Well that's my thoughts right now. Do we need a real lamp, a big 4 or 5-cell type or just a short standard - I'd like to address this one to you, Story, if you would, because in the last test, test 1, actually you got into a lot of equipment repair. And when you try to correlate what you did there with, say, our workbench, would you feel it would be helpful to have maybe a high-intensity lamp at the workbench station to make it - -

MUSGRAVE Yes, but nothing like what's being laid on Skylab. I forget how many candlepowers, but my god it would melt the place.

CHASSAY Is that right?

MUSGRAVE Oh yes. Hessburg put in a fantastic light requirement. You can look at that; we don't need half that.

CHASSAY You don't know what footcandle level he was requesting - -

MUSGRAVE Not in my head, but it'll astound you. In the thousands.

CHASSAY It sounds like an operating room. Okay, on the medical kit, very briefly on that. We had a lot of drugs in there. But just to kind of think a little bit about the mission, can you tell me what types of things, maybe along the lines of bandaids, a splint, anything like that that you may think that you may have to need into it.

MUSGRAVE I wouldn't approach it that way. I'd go to the IMSS and say what do you need from that. Or what should be excluded or included.

CHASSAY Well, we have cut a lot out of it - out of the IMSS and have tried to narrow it down to meet the requirements of a typical mission like we've just run.

SAWIN I think you should have splints, for if someone broke an arm, let's say, - there wouldn't be any need to abort a mission.

CHASSAY Is it really possible for that to happen, say, during a mission?

SAWIN Sure.

CHASSAY What I'm trying to get at - -

MUSGRAVE That's got to be - that whole - we got to tackle the IMSS. I think it, you know - -

CHASSAY That's being worked real hard right now - -

MUSGRAVE I don't think the sim contributes anything to that kit. The Quaalude, yes. We got to take a really hard look at sleeping medication; we're going to need it.

CHASSAY Okay. What I'm thinking like the - comment that Thornton gave us coming out of SMEAT was, hey we don't have enough band-aids. This is for IMSS. So we ended up putting an extra hundred in there, or something like that. Because he was forever getting nicked or cut doing some thing in SMEAT. Or that might be Bill, I don't know. But that was one of the comments that came out. But my question to you here is in running in this facility - or we're talking about a similar type thing, is it very possible to get the nicks and the scratches and things like that working with the exercising equipment?

SAWIN Cracked my knee on that strip chart . . .

CHASSAY Okay, the microscope. That's been mentioned several times here, one of which is an adapter for both still and movie cameras. There was some comment on split or tribeam. Do you have a strong feeling either way?

MUSGRAVE Yes, the tribeam.

CHASSAY The tribeam? Okay. I didn't understand what the white spot was they were talking about.

SAWIN I took off an objective, and it's on a turret with four objectives and we were looking through one but there was light perhaps coming in through the place where I had removed it.

SPEAKER They'll be able to - -

SAWIN That doesn't make sense.

ALEXANDER That's impossible. That can't happen 'cause it's not . . .

SAWIN That's what I'm saying -

MUSGRAVE Let them go work it. They'll go work it.

SAWIN I called them on that but . . . don't believe it. The first time he said it it seemed reasonable then as I thought about it, it didn't make any sense.

CHASSAY Is it worthwhile the type of microscope that was used, to have that on a slide-out type table?

SAWIN It was very inconveniently located. What had happened is that shelf was built, again just prior to the test. We

walked in there and there it was. You couldn't get in there to conveniently look through the microscope, because the TV camera and everything rigidly fixed the location of that microscope.

CHASSAY Okay. So it would be advantageous to have it back out of the way and it slide out to you to - -

MUSGRAVE Like the first sim, yes. Right.

CHASSAY Okay, - -

ALEXANDER Excuse me, Charlie, but we flew an [Leitz] Ortholux over in Huntsville this summer, and all those problems go away because it's reverse mounted and the eye pieces stick out but the whole microscope is back in.

SAWIN Okay, better access by the observer to the eyepiece is what is important, not really where the scope is.

SPEAKER Now the only question is . . .

SPEAKER . . .

CHASSAY Okay, we've have been many miles on the scopes and we certainly don't want to go wrong on the next one we get in there.

CHASSAY How about the work height to this thing. Obviously, you said it was kind of inconvenient; could it have been the height of the - -

SAWIN No, it wasn't the height; it was the fact that you had to lean over this shelf which stuck out there or that you couldn't get your knees under it or anything like that. Real simple human factors.

CHASSAY The types of cameras that may be brought onboard. We obviously use the Polaroid quite a bit. Do you have any strong feelings for the types of cameras that you would like to see?

CLARK I used the Polaroid just for my experiment that was primarily - -

CHASSAY You're the only one that used it?

CLARK Plus just to get some shots of the GDP and that was it.

SAWIN We used the Nikon.

CLARK Story had the other cameras.

MUSGRAVE Yes, the 35 millimeter.

SPEAKER Cameras onboard - . . .

MUSGRAVE You did need an extension tube for very close up photos, specimen photos, culture photos. Biological specimen photography and of course the microscopic stuff.

MUSGRAVE Jim Ragan and the guys downstairs here. They'd like to work that.

CHASSAY Right. I'm just trying to pick your brains at this point in time while the test is just over. This information I'm sure will filter into them. The gas chromatograph, we talked, and there were several things mentioned there. One was the ether evaporation, and I think they mentioned that if they put the ether - there must have been a charge can of some sort - they could put that in the - was there a bottle or a can?

MUSGRAVE No, it was a test tube with a top on it. They were leaking bad.

CHASSAY Okay, I don't understand the operation of this one but this one evidently had a cell voltage flame that - did that ever go out? Was that one of the problems when they shut something off? Was there a shutoff, or was that just a sim problem they were talking about?

MUSGRAVE No, it was all right.

CHASSAY Okay, I thought it somehow went off and you were going to have to relight a flame.

MUSGRAVE That was something that to get the detector's stability back.

CRESS We had a bottle to change out on the outside. . . .

CHASSAY I'm not that familiar with gas chromatographs to know whether or not there would be a different model or different type we would want to fly in zero gravity.

MUSGRAVE This is a home-built one of a kind.

SPEAKER Okay.

MUSGRAVE There aren't any others. It's a super one, but it's a home built.

SAWIN I think if we ever showed Story the one we have over in our lab, he'd never want to look at Howard's again. We have a programmable GC that's digital readout and complete. Just makes this thing look like it's medieval.

CHASSAY Okay; mass spectrometer. One of the things I picked up in our discussion is that it should have extraneous capillary attachments for going into other chambers, and I think that this was mentioned - -

SAWIN We're getting into the important equipment now. I want you to get a mass-spectrometer into that core equipment.

MUSGRAVE And hook it up to the GC.

SAWIN It should perhaps be a more versatile one than the one we have, but a good place to start is with those four basic gasses - O_2 , N_2 , CO_2 , and water. And I've got some things going with Perkin-Elmer. We have a small amount of money to put on it; we need more to put on it. I looked at one of these Skylab-type units modified and have plug-in cards where you can select the gas you want to look at within a mass range up to 120. And that would give you a lot of flexibility for setting up numerous experiments. In other words, some of us spend most of the time looking at these four gases because they are respiratory gases, but there's lots of other things you can do - with a little more versatility in about the same package size. It just means putting a little money into the unit.

CHASSAY Do you have a development program right now with that or - -

SAWIN It's pretty slow and low because there's no money. I know there's a lot of money going into core equipment - -

CHASSAY Right. Well, this is one of the things we - -

SAWIN - - get together and go to work on this thing.

CHASSAY We actually want to look at it - the comments that you might have when we go to, say, preparing a sort of statement of work for purchase for something like this. Whether we want to buy it right off the shelf or go in . . . on the development side and improve its - -

SAWIN There is no off-the-shelf unit that could possibly work in Spacelab.

SPEAKER . . . , is that right?

SAWIN They don't make them . . .

CHASSAY Okay. One of the things that I noted here too is where we have a large magnetic field, do you feel like it would be on - suitable to maybe have an EMI onboard meter of some sort that could maybe do two things. One, detect radiant EMI that you could see in the environment or line EMI that might cause glitches onto maybe some of the readings that you're getting printed out.

MUSGRAVE That's the engineers - -

CHASSAY You said it was a very clean - -

SPEAKER That becomes part of your buildup - -

MUSGRAVE Those guys . . . that stuff, you know.

SAWIN By that I mean, or Story means, I think, when we look at our VCG we didn't see 60 cycle on it.

MUSGRAVE All the stuff we're looking at is operators on the scopes and it's really clean signals, with the one exception the VCG, for some reason when we'd first plug it up it'd be noisy then it would go away. That's what I mean, as operators, as experimenters, everything looked pretty clean.

CHASSAY I know when we put all the equipment into the Skylab vehicle, one of the things that they tested out at Huntington Beach was the EMI that's generated from each system as a total to see whether or not that would affect the vehicle itself, and - -

BOOHER That's part of our job . . . over here in building 36 . . .
down here to make sure the system are compatible with
themselves - -

CHASSAY Well, I was thinking more as a tool to try to find it.
There's something wrong causing the problem here and can
you use it as a tool to check to see if you can shut
some thing off or isolate it somehow from the system so
that it doesn't glitch everything else. Okay - -

MUSGRAVE . . . the diagnostic oscilloscope ought to take care of
that, shouldn't it?

SAWIN It goes down to microseconds, doesn't it?

CHASSAY I have that one and I have your comments on the
oscilloscope on that. One of the things we looked at
would be an oven, and of course that would be used -
possibly considerably in the microbial areas for culture.
That's all the questions that I had right now. Chuck, do
you have any comments on what you might like to see in
addition to this?

MUSGRAVE . . . on that freezer on Spacelab has sent food up in it
and down loading it and putting the samples in it. I
know that Dave Winters is really appalled that we're
flying without frozen food.

SPEAKER It's my understanding that they are now working that
proposal but I'm not that familiar with - Tom Turner
is - -

SPEAKER Well, I don't know how it impacts on designing that
freezer, but it's something to think about when we're
flying in Spacelab, you can put the frozen food in it
and then, as the food comes out, put the samples in.

MANGOLD . . . life science core equipment and trash storage . . .

SAWIN Yes, I brought that up.

CHASSAY Right. That was mentioned. I have not reviewed in detail
some of the work that's already been done, but a few
contractors at Marshall had investigated the core but
right now we're going to have to split those things up
and really go into details and we'll be getting with
you guys. They have a good knowledge of lab equipment,
and how they work and how it impacts the experiments.

MUSGRAVE As a general philosophy, I'd lean toward having things core, because NASA's going to pay for life sciences experiments. And some people say, no, don't make that core, that costs money; let the experiment - payload people pay for that. But you know that isn't the way - who's going to pay for life sciences experiments? HEW isn't going to. NASA's going to pay for it.

BOOHER Neither are the universities or anybody else.

MUSGRAVE Universities aren't going to either, so - -

CHASSAY We obviously are going to have a large number of core items. The question here is, the more inputs we get, the better selection process we'll have for getting these things.

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